

UNIV. OF
TORONTO
LIBRARY



Digitized by the Internet Archive
in 2010 with funding from
University of Toronto

Devoted to the Manu-
facture and Uses
of Portland Cement

Concrete- Cement Age

INDEX Vol. 4

Published Monthly by the

CONCRETE-CEMENT AGE
PUBLISHING CO.
Telegraph Building
Phone: Main 571.

DETROIT

WALTER C. BOYNTON,
General Manager

R. MARSHALL,
Business Manager

BRANCH OFFICES:

NEW YORK: 30 Church Street,
F. F. LINCOLN, Eastern Manager.
Phone: Cortlandt 6452.

PHILADELPHIA: 604 Penn-
sylvania Bldg., **ROBERT W.**
LESLEY, Consulting Editor.

CHICAGO: 1020 1st Natl. Bank
Bldg. **R. N. JACKSON,** West-
ern Manager: Phone: Central
6502.

CLEVELAND: 794 East 95th St. **JOHN**
H. BYRNE, Manager.

SPOKANE, Wn.: 1108 Spofford Ave.,
FRED NIEDERHAUSER, Manager.

SUBSCRIPTIONS: \$1.50 a year; single copies
15 cents. Canadian subscription, \$2.00 a
year. Foreign subscription \$2.50 a year.
In requesting change of address give for-
mer address also.

ADVERTISING: Rates upon application.
Complete information regarding size, char-
acter and distribution of circulation cheer-
fully furnished upon request.

CORRESPONDENCE on all matters relating to
the industry which the magazine repre-
sents is solicited by the Editors. Discus-
sions, notes and inquiries will be gladly
received.

Readers are especially invited to report
their own work—to explain the problems
which they solve—so that their magazine
may really be an institution for the ex-
change of ideas of value in the industry.

Copyright 1914 by

CONCRETE-CEMENT AGE Publishing Co.

Entered as Second Class matter at the Detroit Post-office

Vol. 4

JANUARY-JUNE, 1914

No. 1-6

ROBERT W. LESLEY, Consulting Editor

HARVEY WHIPPLE, Managing Editor

JEROME COCHRAN, Technical Editor

For the greater convenience of the reader this index has been made both titular and topical in nature. Original titles of articles have been amplified or condensed for the purposes of the index as seemed best. Subjects have been indexed which are treated in articles and not originally embraced in the title. Nothing has been indexed under "concrete" and nothing under "cement" except when the nature or testing of cement is involved or some statistics as to its production or use. In short, "cement" has been used as an index word only when it appeared as the only comprehensive way of designating the matter. Illustrated articles are denoted by an asterisk after the title. Editorials are designated by "E"; articles in the Information and Consultation department by "I-C"; Correspondence department matter by "C" and New Equipment Methods and Materials department articles by "Eq." The months and pages are given.

A

Administration, Construction, Organization, C Feb. 84
Aggregates for Concrete Roads, ... Mar. 123
—In Pipe Manufacture, Grading of June 281
American Cement Pipe Assn., Convention of Mar. 110
—Concrete Inst., ... Mar. 101
—Concrete Inst., Tenth Annual Convention Mar. 105
—Highway Assn., ... Apr. 198
—Road Builders Assn., Convention and Exhibition Jan. 30
—Road Builders Assn., Officers and Convention Apr. 198
Anchors, New Way of Attaching Screw, ... Feb. 99
Andover, Mass., Concrete Roads, ... Mar. 129
Architect, Concrete's Appeal to, C, ... Mar. 138
Architects, To, E, ... Feb. 48
Architectural Appeal of Concrete Block Wall Units, ... Apr. 195
—Possibilities in Concrete, ... Apr. 171
—Treatment in Factory Building, ... May 213
Architecture, Beauty and Economy in Simplicity of, E, ... Apr. 153
Artistic Concrete, Developing, ... Mar. 107

B

Balustrade in Garden on Castana Estate, ... May 220
Bar-Shear, Compounding, Eq, ... May 254
Bennis, Economic Design of Concrete, ... May 246
—Supporting Shafting from Concrete, ... Mar. 109
Beds for Machinery, Concrete, ... May 240
Belt Conveyors in Heavy Concrete Dam Construction, Use of, ... May 226
Bin, Concrete, for Mine Tailings, ... June 272
Bituminous Surfaces for Concrete Roads, ... Mar. 146
—Surfaces on Concrete Roads, ... May 232
Block and Tile Cars in Products Plants, Painting, I-C Feb. 81
—Concrete, Building Low Cost Houses in England, C, ... Apr. 185
—Concrete, Wall Units, Architectural Appeal of, ... Apr. 195
—Concrete, with Interesting Facing, House Built of, ... Apr. 167

—Facing Materials for, ... Apr. 195
—Layout and Operation of Plant for Wet Process, ... Feb. 63
—Manufacture of Concrete, for Panama Houses May 221
—Triple-Walled Concrete, Develops Continuous Air Space and Solid Wall, ... June 279
—Wet Process, New Molds for, Eq, Apr. 203
Boston's New City Hall Annex, Production in Concrete of Statues for, ... May 222
—New Dry Dock, ... May 238
Bridge, Arch, at San Diego Exposition, ... Jan. 10
—Construction, Concrete, by St. Louis Park Department, ... Mar. 127
—Construction, Green Concrete in Place Moved in Mass Without Apparent Damage in, C, ... Feb. 83
—Construction, Green Concrete in Place, Moved in Mass Without Apparent Damage in, C, ... June 290
—Construction, Movements and Stresses in Green Concrete in Relation to, C May 243
—of Reinforced Concrete with Unique Surface Effects, ... Jan. 8
Bridges, Concrete, in St. Louis Parks, ... Feb. 98
—Details of Concrete, ... Feb. 82
British Guiana, A Cathedral in, ... Apr. 198
Buildings, Concrete, Putting on the Map, E Feb. 47
—Expansion Joints in Reinforced Concrete, I-C Feb. 288
—Tests on Reinforced Concrete, ... Mar. 107
Bulk Cement, Economy of, ... June 292
Bungalows, Albany, N. Y., with Asbestos Stucco, ... Apr. 175

C

Canada Cement Co. Closes Four Plants, ... Feb. 92
Canvas Curtains for Steam Rooms, Treating, I-C May 244
Carpenters and Form Builders, E, Feb. 48
Cascade Mountains, Concrete Snow Sheds in, ... Jan. 13
—Mountains, Snow Sheds in, ... Feb. 89
Catalogs, Standard Sized, C, ... June 289
Cathedral in British Guiana, ... Apr. 198
Ceilings, Suspended, in Concrete Roof Construction, I-C May 243
Cellar Steps of Concrete, Construction of, ... June 279
—Walls, Waterproofing, I-C June 285
Cement, A Quick-Setting, I-C June 286
Cause of Alkali, I-C, ... Apr. 187
Is It a Reversible Colloid, I-C, ... June 288
—Portland, Production in 1913, ... May 256
Centering for Concrete Standpipe, ... Feb. 51
—Removing May 240
—Standard Sizes Make for Economical Mar. 116
Chalk Line, Wire in Place of, ... Mar. 129
Chevy Chase Road, Some Notes on Wear of Feb. 97
Chicago Cement Show, ... Jan. 30
—Cement Show, E, ... Mar. 101
—Cement Show Mar. 145
—Cement Show, Next, Feb. 16-17, ... June 297
Chimneys, Insurance Regulations Relative to Residence, I-C, ... Feb. 76
Chutes, Boom-Supported, for Conveying Concrete, The Erection of, ... Jan. 43
Cinder Concrete for Wall Construction, I-C June 281
—Concrete Insulation in Roof Construction, I-C May 242
—Fill in Concrete Roof Construction, I-C May 241
—Foundation in Sidewalk Construction, I-C Feb. 36
Cinders Under Concrete Roadways, C, Feb. 84
Clamp, A One-Piece Flexible Column, ... Eq, ... Mar. 149
Cold Weather, Using Steam to Heat and Cure Double Walls in, ... Feb. 95

Colloid, Is Cement a Reversible, I-C, June	258
Coloring Concrete by Penetration Method, in Garden on Castana Estate, *	210
Column Detail in Factory Building, *	May
Columns, Change of Size in Concrete, Jan.	22
—Investigation of Concrete, Mar.	107
—Purch. Cast in Place, Apr.	186
Compacting Concrete, Pressure Required in, I-C, *	May 213
Concrete and Steel, Feb.	47
Condensation on Concrete Roof Slabs, Prevention, I-C, *	May 211
Construction, Organization, Administration, C, *	Feb. 81
Contraction and Expansion of Concrete Roads, Mar.	119
—Joints in Sidewalks, I-C, *	Mar. 134
—Joints in Sidewalks, I-C, *	June 284
Conveying Concrete, Erection of Boom-Supported Chutes for, *	Jan. 43
Cracks in Road Construction, *	May 233
Crushers, Stone, in Concrete Work, *	Jan. 28
Culvert Pipe Wrapped in Canvas in Railway Work, *	Mar. 103
Cure Double Walls in Cold Weather, Using Steam to Heat and, *	Feb. 95
Curing Concrete Road Surfaces, *	Mar. 147
D	
Dam Construction, Comparative Materials for I-C, *	Jan. 35
—Construction, Use of Belt Conveyors in Heavy Concrete, *	May 226
—Over 40,000 cu. yds. of Concrete Placed in Month, *	May 233
Decorative Work, E., *	May 207
Design and Construction of 12-Story Reinforced Concrete Factory-Building, *	May 209
Drainage and Irrigation, Concrete in, Feb.	93
Dry Dock, Boston's New, *	May 238
Dust, Stone, in Pipe Manufacture, *	June 281
E	
Egypt, Railway Construction Work Near Cairo, *	Mar. 103
Engineering Congress, The International, E, *	June 258
England, Building Low Cost Concrete Block Houses in, *	Apr. 185
—Concrete House Design in, *	May 238
—Water Tower near York, *, Jan.	12
European Opposition to Concrete, E., *	June 257
Expansion and Contraction of Concrete Roads, *	Mar. 119
—Cracks in Reservoir Construction, I-C, *	Feb. 80
—Joint for Pavement Work, Eq., Jan.	46
—Joints in Reinforced Concrete Structures, I-C, *	June 288
Extras on Construction Work, *	Jan. 43
F	
Facing, House Built of Concrete Block with Interesting, *	Apr. 167
—Materials for Block, *, *	Apr. 195
Factory Building, Design and Construction of 12-Story Reinforced Concrete, *	May 209
—Building, Windsor, Ontario, Saw-Tooth Concrete Roof Construction on, *	June 293
—Construction, Relative Values in Sale, C, *	Feb. 80
Fail, Why Does Concrete Occasionally, C, *	Mar. 136
Fence, Concrete, Constructed in Easily Portable Units, C, *	Feb. 85
Field Stone in Interesting and Economical Construction, *, *	Jan. 6
Finishing Concrete Road Surfaces, *	Mar. 147
Fire Escape Stairways Details in Factory Building, *	May 214
—Loss and Concrete Buildings, E., Feb.	102
Fireproof Construction Mandatory, *, Feb.	90
Homes, Build, E, *	Apr. 153
Floor Construction, A Surface Finish 9 Inches Thick in, *	Mar. 127
—Construction, Best Way to Handle Top Finish in, I-C, *	June 280
—Construction, Drainage and Releveling, Open-End Tile Cores in Fireproof, *	Apr. 161
—Sleepers in House Construction, Apr.	175
Steel Arrangement in Factory Building, *	May 212
—Waterproofing Cellular, I-C, *	June 285
Floors, Concrete, in Soap Factories, I-C, *	Feb. 80
—Concrete, Methods for Patching Holes in, *	Mar. 104
—Concrete, Sodium Silicate Solution for, I-C, *	Mar. 135
—Dusting of Concrete, Jan.	34
—Mushroom Ventilators for Concrete, *, Eq., *	Feb. 99
—Tile, *, *	Apr. 101
Flower Box, *, *	Feb. 59
Boxes in Garden on Castana Estate, *	May 219

Boxes of Concrete Cast in Simple Wood Molds, *	May 221
—Lris in Garden on Castana Estate, *	May 219
Flues, Smoke, Curers with Concrete, *, C, *	Jan. 37
Form Builders and Carpenters, E., Feb.	43
—Self-supporting Unit Wall, Made of Metal-Faced Wood, *	June 277
—Wall, Self-Angling, *	Apr. 186
Formas, Steel, and Contractors' Problems, *	Mar. 107
—Steel, in House Construction, Jan.	3
—Steel, Used in House Construction, *	Apr. 139
—Steel Wall, for Retaining Wall Construction, *	Mar. 131
Foundation of Concrete Standpipe, *	Feb. 57

G

Garages of Reinforced Concrete, How to Build Small Fireproof, *	Jan. 17
Garbage Receptacle, Eq., *	Mar. 150
Garden Ornamentation on Castana Estate, Use of Concrete in, *	May 216
—Walls Built in Tight Forms with Grout and Stone, *	Jan. 9
—Water, Use of Concrete in the Construction of a, *	Feb. 49
Gauge Glasses, Preventing Broken, Feb.	82
Gih, Irving J., Architect, Concrete Houses, *	Apr. 155
Grain Elevator at Winnipeg, *, *	June 269
Great Northern Railway, Concrete Saw Slabs in the Cascade Mountains Built by, *	Jan. 13
Green Cement, Relation of Strength to Temperature of, *	Jan. 19
—Cement, Relation of Strength to Temperature of, *	Jan. 13
—Concrete in Place Moved in Mass Without Apparent Damage in Bridge Construction, C, *	Feb. 83
—Concrete in Place Moved in Mass Without Apparent Damage in Bridge Construction, C, *	June 290
—Concrete Movements and Stresses in Relation to Bridge Construction, *	Mar. 248
Grenoble, France, Sidewalks and Pavements of Concrete in, *	Jan. 23
—France, Sidewalks and Pavements of Concrete, *	Jan. 23
Grout, in Concrete, Engineering and Economical Construction, *, *	Jan. 6

H

Handling and Hauling of Materials in Road Construction, *	May 234
Heat Generated by Setting Concrete, I-C, *	June 288
Hoist, A Simple Details, *, Eq., *	Apr. 205
—House-Made, Details of and Its Operation, *	June 276
Hoisting Engine, Light, Eq., *	Apr. 205
—Rigs, Hand-Power, for Small Work, *	Apr. 200
Homes, Build Fire-Proof, E., *	Apr. 153
Hot Well in Paper Mill, Concrete for, *	June 275
House Building, Concrete, Practical Suggestions from a Builder, *	Apr. 174
—Built of Concrete Block with Interesting Facing, *	Apr. 167
—Concrete, Economy and Simplicity in Building, *	Apr. 155
—Concrete, San Diego, Cal., Apr.	155
—Construction, Tufa Concrete, Steel Forms and Efficient Equipment in, *	Jan. 3
—Construction, Unusual Features in, Made Possible by Use of Concrete, *	Apr. 105
—Design in England, Concrete, *	May 228
—Use of Sand-Cast Concrete Veneer Slabs in Louisville, *, *	Apr. 176
Houses, Concrete, at Low Cost, Midland, Pa., *	Apr. 159
—Concrete Block, in England, Building at Low Cost, *	Apr. 185
—Concrete, for Government Employees in Panama, *	May 221
—Concrete, Living in, C, *	Apr. 190
—Concrete, Revision of Development, Construction of, 1907 to 1914, *	Apr. 168
—That Are Homes, E., *	Feb. 47
—Use of Sand-Cast Concrete Slabs in Two Louisvilles, *	Apr. 151
Housing, Scottish, E., *	Apr. 151
Hydrated Lime in Concrete Mixtures for Pavements, Use of, *	Jan. 239
Ily-Rib, Seven Rib, Eq., *	May 46

I

India, Use of Reinforced Concrete in, *	Feb. 68
Infirmity, Scottish, Built of Reinforced Concrete, *	Jan. 5
Insulating Brick Walls, I-C, *	Jan. 56
—Values of Structural Materials, I-C, *	Mar. 135
Interstate Cement Tile Mfrs. Assn., *	Jan. 40

Inventions, Recent, in the Concrete Field, *	June 278
Iowa State College, Cost of Concrete Pavement, *	Feb. 73
Iron Standing Scaffolding, E., *	June 269
Irrigation, Concrete in Drainage and, *	Feb. 93

J

Jack for Raising Centering, *, Eq., *	Apr. 205
Jars, Modeling Concrete, *	Apr. 173
Joint, Expansion, for Pavement Work, Eq., *	Jan. 46
Joints, Contractions in Sidewalks, I-C, *	June 284
—Expansion, in Reinforced Concrete Buildings, I-C, *	June 288
—for Concrete Roads, Mar.	123
—in Concrete Road Construction, *	May 232
—Lynn, Mass., Lays Concrete Paving Without, *	Mar. 120
—New Plate for Pavement, *, Eq., *	Feb. 100

K

Keenel Building with Capacity for 1,000 Hounds, *	Jan. 6
Knowledge, Less, But More To, *	June 257

L

Labor the Big Item in Concrete Construction, *	Apr. 206
—Troubles, A Day of Handling, Mar.	111
Laboratories, Testing, for Concrete, *	Feb. 97
Ladder Foot for a Concrete Floor, *, *	May 226
Lake Spaulding, Cal., Dam, *	May 226
Lamp Posts, Hollow Concrete, for Panama Canal, *	June 250
Lath Corrosion, Investigation of Metal, *	Mar. 108
Lime, Cream of, *, *	Apr. 182
—Hydrated, Effect on Change in Volume and Strength of Mortars and Concretes, *	Mar. 112
—Hydrated, How Does it Add to the Strength of Concrete, I-C, *	Mar. 130
—Hydrated, Problems in Use of, C, *	June 290
—Hydrated, Use of in Concrete Paving, C, *	Feb. 87
—Putty, *	Apr. 182
—with Portland Cement, Mar.	108
Louisville, Ky., Uses of Sand-Cast Concrete Slabs in Two Houses, *, *	Apr. 193
—Store Building, Stucco with Tile Inlay Work on, *	May 215
Lubricant, A New Form, Eq., *	Apr. 205
Lynn, Mass., Lays Concrete Paving Without Joints, *	Mar. 126

M

Machinery, Concrete Beds for, *	May 240
Mazda, A Stronger, *	June 257
Maintenance in Road Construction, *	Mar. 146
Materials, Handling and Hauling of, in Road Construction, *	May 234
—Motor Trucks as Modern Construction Equipment in Movement of, *	June 265
Midland, Pa., Manufacturing Concrete Houses at Low Cost at, *	Apr. 159
Mills, Educating The Cement User, *	May 215
—Showing, *	Mar. 116
Milwaukee Has a Bureau of Quantity Surveying, *	May 231
Mine Tailings, Concrete Bin for, *, *	June 272
Mississippi, Lower, Construction of a Concrete Sea-Wall on, *	Jan. 15
Mix, Brains in the, E., *	Jan. 1
Mixer, A Double Drum, Eq., *	June 299
—A Light Batch, Eq., *	May 235
—A Light Batch with Hoist Attachment, *	June 299
—Chain Belt Paving, *, Eq., *	Apr. 203
—Continuous, Equipped for Auto Tracing, *, Eq., *	June 299
—Home-Made, Details of and Its Operation, *	June 276
—How to Clean Concrete from a, I-C, *	Feb. 32
—How to Clean Concrete from a, I-C, *	Feb. 78
—Made of a Barrel, *	Jan. 13
—Need of small, E., *	May 207
—Use of a Small Double Cone Batch, *, Eq., *	Jan. 44
—Measuring Cement for Small Batch, C, *	Mar. 136
—Proportioning Water for Batch, Eq., *	May 255
—Used to Load Wagons, *	June 261
Mixing and Placing Materials in Road Construction, *	May 235
—Concrete to Road Construction, *	May 232
—Materials for Concrete Roads, *	Mar. 147
—Plant Used in Factory Building Construction, *	June 282
Mixture in Pipe Manufacture, *	June 282
Mixtures, Special for Special Results, E., *	May 207
Modeling Concrete Jars, *	Apr. 173
—In Clay, Slabs for Boston's New City Hall Annex, *	May 222
Motor Truck, Making It Pay in Contracting, *	June 296

—Trucks as Modern Construction Equipment in Movement of Materials, *	June 265
—Trucks on N. Y. Subway Work, Handling Concrete with, * C.	Apr. 191

N

National Conference on Concrete Road Building	Jan. 41
—Conference on Concrete Road Building	Mar. 117
Nebraska Cement Users Assn.	Jan. 40

O

Ohio State Highway Department, Concrete Road Construction by	May 229
Oil, Storage Tanks for, I.C.	Feb. 79
—Storage Tanks for, I.C.	Apr. 187
Omaha Cement Show	Jan. 40
Organization, Construction, Administration, C.	Feb. 84
Ornamental Concrete Products Manufacture, *	Feb. 59

P

Pails Used for Measuring Cement	Jan. 31
Paint Films as Protective Coatings for Concrete, The Use of, C.	June 291
—Films Used as Protective Coatings for Concrete, *	Apr. 177
Pamphlets, Standard Size, C.	Mar. 289
Panama Canal, Hollow Concrete Lamp Posts for	June 239
—Concrete Houses for Government Employees in	May 221
Paper Mill, Concrete for Hot Well in	June 275
Papers, Feverish Discussion, E.	June 227
Patent Office, Some Details from, *	June 278
—Settled, Wet Concrete	Feb. 89
Patented Processes, E.	May 208
Patents, Design, New Rules on, Jan. 16	Jan. 16
—Review of Some Recently Issued in the Concrete Field, *	Jan. 29
Pavement, Concrete, Surface on Grades, I.C.	Jan. 34
—Concrete, Surface on Grade, I.C.	Feb. 81
—Concrete, Surface on Grades, I.C.	May 244
—Cost of Concrete, Iowa State College	Feb. 75
—Work, Expansion Joint for, E.	Jan. 46
Pavements, Concrete	Mar. 105
—of Concrete in Grenoble, France	Jan. 23
—of Concrete, Grenoble, France	Feb. 94
—Use of Hydrated Lime in Concrete Mixtures for	May 239
Paving, Concrete, Experiment at Phoenix, Ariz., C.	Mar. 137
—Concrete, Without Joint, E.	Mar. 126
—Four Causes for Defects in Concrete	Jan. 21
—Use of Hydrated Lime in Concrete	Feb. 87
—Width of Joint in Concrete, I.C.	Feb. 82
Pergola in Garden on Castana Estate, *	May 217
Permanence in Essential to Beauty, E.	June 253
Philadelphia, School of Industrial Art, *	Feb. 59
Phoenix, Ariz., and How of Placing Cement At, C.	Mar. 137
Piles, Use and Cost of Concrete Pedestal	Jan. 31
Piling, Sheet, Retaining Wall, C.	Mar. 138
Pipe, A Recipe for	June 271
—Concrete, How It Has Helped Development and Been Developed in the West, *	June 270
—Concrete Sewer, Material and Methods Used in Manufacture of, *	June 280
—Curing Concrete	June 283
—Extensive Tests on	June 106
—Manufacture, Grading and Aggregates	June 281
—Manufacture, Mixture in	June 282
—Manufacture, Percentage of Silic	June 280
—Manufacture, Stone Dust in	June 281
—Tests on Plain and Reinforced Concrete	June 250
Pittsburgh Concrete Steel Co., Con., Pa., Erected Concrete Houses, *	Apr. 159
—Extensive Railroad Concrete Work at, *	Feb. 98
Placing and Mixing of Materials in Road Construction	May 235
Concrete Under Water, I.C.	Feb. 82
Materials for Concrete Roads, I.C.	Mar. 147
Plaster, Mold for Statues for Boston's New City Hall Annex, *	May 223
Plastering Concrete Walls, I.C.	Mar. 131
Pneumatic Equipment for Placing Cement Mortar, E.	Apr. 45
—Tampers in Products Manufacture, Use of, I.C.	May 244
Pole, New Type of Reinforced Concrete, E.	Apr. 100
Poles, Concrete Service, Withstand Storm	June 272

Polishing Machine, Power, for Terrazzo Work, * E.	June 298
Posts, Concrete Fence	Mar. 108
—Concrete, Making Economically, Feb.	99
—Fence, Plant Exclusively for Manufacture of, *	Apr. 199
—Hollow Concrete Lamp, for Panama Canal	June 259
Pressure, Required in Compacting Concrete, I.C.	May 243
Prices, Current—Concrete Materials	June 297
Production, Manufacture, Concrete, Lay-out of Steam Rooms, I.C.	Feb. 81
—Manufacture, Construction and Lay-out of Steam Rooms, I.C.	Mar. 132
—Manufacture, Ornamental Concrete, *	Feb. 50
—Manufacture, Use of Pneumatic Tampers in, I.C.	May 244
—Plants, Layout of	Mar. 111
—Pneumatic Broom and Trowel in, I.C.	81

Q

Quantity Surveying, Milwaukee Has a Bureau of	May 234
—Surveyor, Who Pays the, C.	Feb. 85

R

Rakes to Mix Sidewalk Materials, Using C.	Feb. 87
Railroad Concrete Work at Pittsburgh	Feb. 87
Railway Construction Work near Cairo, Egypt	Mar. 103
Reinforcement, Absurdity of Wood, Mar.	140
Reinforcements in Road Construction	Mar. 124
Reinforced, Effect of Salt Saturation Concrete, I.C.	Mar. 133
Repair and Maintenance in Road Construction	Mar. 146
Residual, Concrete, Used as Filling in Park	Feb. 68
—Construction, Expansion Cracks in I.C.	Feb. 80
—Concrete to Hold 65,000 Gallons, *	7
Retaining Wall Construction, Use of Steel Wall Forms for, *	Mar. 151
—Wall, Sheet Piling, C.	Mar. 138
—Walls, Individual Openings in, *	Apr. 181
Road Building, First National Conference on Concrete	Mar. 117
—Building, Further Reports from First National Conference on, *	May 234
—Chevy Chase, Some Notes on Wear of	Feb. 97
—Concrete, Give Mile to County, Apr.	195
—Concrete, How to Break Up, Anticipated, *	Jan. 22
—Concrete, Maintenance, E.	Feb. 48
—Conference, E.	Mar. 102
—Construction, Best Practice for Concrete, *	Jan. 25
—Construction, Concrete, by Ohio State Highway Department	May 229
—Construction, Concrete, Economical, if Only for Foundation Value, *	Mar. 125
—Construction, Concrete, Recommended by National Conference	Mar. 117
—Construction, Concrete, Review of Practice and How of Placing	Feb. 71
—Construction, Reinforcement in	Mar. 124
—Construction, Sub-Grade in	Mar. 124
—Laws, Work for Improvement of State	Feb. 70
—Maintenance Methods and Costs for 1913 in Wayne County, Mich.	Feb. 69
—Surfaces, Finishing and Curing Concrete	Mar. 147
Roads, Aggregate for Concrete, Mar.	123
—Bituminous Surfaces for Concrete	Mar. 146
—Concrete, Cost of Constructing, *	Mar. 147
—Concrete, Expansion and Contraction of	Mar. 119
—Concrete, in Andover, Mass., *	Mar. 129
—Concrete, Mixing and Placing Materials for	Mar. 147
—Form of Specifications for Concrete	Mar. 148
—Joints for Concrete	Mar. 123
—Proportion and Consistency of Materials for Concrete	Mar. 146
—Shoppers for Concrete	Mar. 148
—Thickness, Crown and Grades for Concrete	Mar. 148
Roadways, Cinders Under Concrete, *	Feb. 84
Rock Mixtures for Portland Cement, Jan.	24
Roof, Double, of Concrete Slabs, I.C.	May 242
—Requirements in House Construction	Mar. 175
—Slabs, Prevention of Condensation on Concrete, I.C.	May 241
—Tile Machine, Concrete, E.	Apr. 204
Roofs, Composition, Instead of, Jan.	40
Gravel, E.	Jan. 40
—Methods of Applying Composition, I.C.	Apr. 188
—Preparation, E.	Apr. 188
Roofs, Required Thickness for Concrete, I.C.	May 240

Sacks, Baling and Counting Empty Cement, E.	May 235
—Size of Cement	Apr. 181
—Trading in Stone, Mar.	238
St. Louis Parks, Concrete Bridge in	Feb. 98
—Park Department Constructs Concrete Bridge	Mar. 127
Salamanders, Cost of Operating, I.C.	Mar. 146
Salt Solution, Effect on Concrete Reinforcing, I.C.	Mar. 133
San Diego, W., Concrete House, Apr.	155
—Exposition, Concrete Arch Bridge	Jan. 10
Sand-Cast Concrete Slabs Used in Two Louisville Houses, *	Apr. 193
—Concrete Veneer Slabs Used in Louisville House, *	Apr. 176
Saw-Tooth Concrete Roof Construction on Factory Building, Windsor, Ontario	June 293
School Building, Simple Architectural Lines Characterize Construction of	June 262
Scottish Infirmary Built of Reinforced Concrete, E.	Jan. 5
Screen, Small Revolving Sand, E.	June 297
Sea-Wall, Concrete, on Lower Mississippi	Jan. 15
Sea Water, Tests on Its Action on Concrete	June 273
Seat in Garden on Castana Estate, *	May 217
Sewer Pipe, Concrete, Material and Methods Used in the Manufacture of, *	June 280
—Pipe, 30-Year-Old	June 271
Shafting Supported from Concrete Beams	Mar. 109
Shoulders for Concrete Roads	Mar. 146
Show, Chicago Cement	Jan. 39
—Chicago Cement, E.	Mar. 101
—Chicago Cement, Used as Filling in Park	Mar. 145
—Omaha Cement	Jan. 40
Sidewalk Construction, Cinder Foundation in, I.C.	Jan. 36
—Light, A Detachable, * E.	Jan. 46
—Materials, Use of, Lakes, C.	Mar. 87
—Surface, Failure of, I.C.	Jan. 33
—Surface, Failure of a, I.C.	Feb. 79
—Surface, Neat Cement on, I.C.	Jan. 34
—Surface, Neat Cement on, I.C.	Apr. 187
Sidewalks and Pavements of Concrete, Grenoble, France	Feb. 94
—Contract Joints in, I.C.	Mar. 134
—Contract Joints in, I.C.	June 284
—of Concrete in Grenoble, France	Jan. 23
Silo, Construction, Concrete Distributing Equipment for, E.	Apr. 203
—Doors on a Maryland	Feb. 92
Silos, Concrete, in South Africa, *	Jan. 16
—Insuring Against Drought with Concrete	Mar. 152
—Pit and Above-Ground	May 231
—Tight Doors for Concrete	Mar. 152
—Why Should Be Round, I.C.	May 243
Silt, Percentage of in Pipe Manufacture	June 280
Slab, Flat, Work in Concrete, I.C.	June 290
Slabs, Sand-Cast Concrete, Use in Two Louisville Houses, *	Apr. 193
—Sand-Cast Concrete Veneer, Used in Louisville House, *	Apr. 176
Show Sheds, Concrete, in Cascade Mountains, *	Jan. 13
—Sheds in the Cascade Mountains, Feb.	89
Soap Factories, Concrete Floors in, I.C.	Feb. 80
Sodium Silicate Solution for Concrete Floors, I.C.	Mar. 133
South Africa, Building Concrete Silos in, *	Jan. 16
—Concrete Development in, *	June 292
Specifications for Concrete Roads, Form of	Mar. 148
Stair Unit with Interesting Possibilities, *	Feb. 273
Stairways, Details of Fire Escape, in Factory Building, *	May 214
Standpipe, Concrete, Field Notes on the Construction of, at Albany, N. Y., *	Feb. 53
Statues for Boston's New City Hall Annex, Production in Concrete of, *	June 222
Steam Room Curtains, Treating Canvas for, I.C.	Mar. 131
—Room Doors	Mar. 111
—Rooms in Products Manufacture, Construction and Layout, I.C.	Mar. 81
Rooms in Products Manufacture, Construction and Layout, I.C.	Mar. 132
—Rooms, Treating Canvas Curtains for, I.C.	May 244
—To Heat and Cure Double Walls in Cold Weather, *	Feb. 95
Steel, and Concrete, E.	Feb. 47
—Weight, Composition, C.	Apr. 159
Step Form, New Adjustable, * E.	Mar. 150
Steps, Cellular, of Concrete, *	June 279
—One Way to Make Noise on Concrete, E.	Apr. 254
Stone, Concrete, From an Antiquary's View point	Jan. 128

Concrete, Used Effectively with Red Brick, *	June 274
—Manufacture, Artificial Travertine, for Paama-Pacific Exposition, C.	Jan. 33
—The New Concrete, E.	Apr. 153
—Washing Crushed, I.C.	Jan. 33
—Washing Crushed, I.C.	Feb. 77
Strength, Relation to Temperature of Green Cement,	Jan. 19
—Relation to Temperature of Green Cement, C.	Mar. 138
Stucco, Architectural Possibilities in, *	Apr. 171
—Asbestos, Bungalow in Albany, N. Y., *	June 174
—Coat, Rough, An Example of, *	June 296
—Coatings, Field Difficulties in Applying, C.	June 289
—Practice, Standard	Mar. 108
—Repairing Unsatisfactory, I.C.	May 243
—Rough-Cast, over Plaster Bond	Apr. 174
—with Tile Inlay Work on Louisville Store Building, *	May 215
Sub-Grade in Road Construction	Mar. 124
Subway Work, N. Y., Handling Concrete with Motor Trucks, *, C.	Apr. 191

T

Tanks, Storage, for Oil, I.C.	Feb. 79
—Storage, for Oil, I.C.	Apr. 187
Temperature of Green Cement, Relation of Strength to,	Jan. 19
—of Green Cement, Relation of Strength to, C.	Mar. 138
Terrazzo Work, A Power Polishing Machine for, * Eq.	June 298
Testing Materials, Standardization of,	Mar. 108
—Methods, Report on Standardizing, *	Mar. 141
Tests, Report on Standardizing, *	Mar. 141

Tile and Block Cars in Products Plants, Painting, I.C.	Feb. 81
—Concrete, Portable Machine to Make in Place,	June 278
—Floors, *	Apr. 161
—Hollow, Insulation in Roof Construction, I.C.	May 242
—Inset, for Decorating Concrete Surfaces, Detail Showing Method of Arranging, *	June 278
—Machine, New Automatic, Eq.	Apr. 202
—Machine, New Power, *, Eq.	Mar. 149
—Manufacturers, Convention of,	Mar. 110
—Possibilities of Mural Decorations with Inlaid, *	Apr. 200
—Specifications for	Mar. 110
Tower, Stairway, Used in Construction of Concrete Standpipe, *	Feb. 57
—Water, An Amateur's Makes Good, C.	June 291
—Water, near York, England, *	Jan. 12
Tree Dentistry Is Practised with Concrete,	Jan. 42
Tremie Work, A Good Precaution for Deep Water	Jan. 30
Troughs, Feeding, Durable and Sanitary of Concrete, *	Mar. 108
Trowel, A Long-Handled Geared, *	June 300
Truck, Motor, Making It Pay in Contracting,	June 290
Trucks, Motor, as Modern Construction Equipment in Movement of Materials, *	June 265
Tufa Concrete in House Construction, *	Jan. 8
Turkey, Architectural Concrete Units in House in	May 249

U

Units, Construction of Concrete Fence in Easily Portable, C.	Feb. 85
Unusual Paving Methods	June 261

V

Vase, Garden, of Concrete, *	Apr. 187
Vases, Garden, *	Feb. 59
Vaults, White Surface for Burial, I.C.	Jan. 31
Ventilators, Mushroom, for Concrete Floors, *, Eq.	Feb. 99

W

Wall, Curtain, Efficiency,	Feb. 75
Walls, Garden, Built in Tight Forms,	Jan. 9
—Hollow, in House Construction	Apr. 174
Washing Crushed Stone, I.C.	Jan. 33
—Crushed Stone, I.C.	Feb. 77
Waste Burner, Concrete, C.	June 292
Water Garden, Use of Concrete in the Construction of a, *	Feb. 49
—Placing Concrete Under, I.C.	Feb. 82
—Tower, An Amateur's, Makes Good, C.	June 291
—Tower near York, England, *	Jan. 12
Waterproof Concrete, Make Experiments in	Jan. 22
Waterproofing Against Pressure, I.C.	Apr. 180
—an Orchestra Pit, Eq.	May 256
—Cellar Walls and Floor, I.C.	June 285
—Necessary in House Construction	Apr. 175
Wayne County, Mich., Road Maintenance Methods and Costs	Feb. 69
Well, Hot, in Paper Mill Made of Concrete, *	June 275
Wells, Covers of Concrete Keep Impurities Out of Water, *	Jan. 18
White Cement, Use of, I.C.	Jan. 35
Winnipeg, Grain Elevator at, *	June 269
Wire in Place of Chalk Line	Mar. 129

Concrete-Cement Age

Vol. IV.

January, 1914

No. 1

Service

WE should like to have you think always of CONCRETE-CEMENT AGE as an institution for the advancement of knowledge and the promotion of efficiency in the field of concrete. Its chief function is the publication of a magazine twelve times a year which shall reflect and in a measure anticipate the ways and the means of progress in its field, but it goes beyond this. It is for *Service* to you—the individual reader.

Making Information Accessible

PROBABLY it never occurs to you as a reader of CONCRETE-CEMENT AGE that the greatest problem of the Editors is to get the magazine read. The Editors of CONCRETE-CEMENT AGE every month feel a warm elation—they feel as the publication is turned over to the mailers; here goes to each individual reader a package of valuable information. Yet the editorial enthusiasm in this respect is somewhat cooled in the occasional realization that this package isn't everywhere thoroughly explored. With these thoughts in mind, certain changes in make-up become effective with this issue. These changes have been seriously and minutely considered with relation to the effect which they will have upon the reader in enabling him to get at more readily the matter in which he is most interested. Special attention is called to the Topical Index on the Editors' own page, which is the second inside the front cover. You should form the habit of turning first to this page and by scanning the subjects which are arranged as conveniently and accessibly as possible, you can determine at once just those things in the magazine which are of special value to you.

The Men Who Know

MONTH in and month out probably the best matter in this magazine is published under the heading: Information and Consultation—The How-to-do-It Department. There are handled the subjects and individual problems which come to us hot from the activities of the field and which we turn over for discussion to the *men who know*.

We cannot emphasize too strongly the importance and value of this department. We feel that the form in which the discussions have heretofore been published did not make the most of the value contained in the matter. So we have included in our new make-up some radical changes in the presentation of this department so as to make as prominent and as conspicuous as possible—and therefore easier to be found by you—the discussions which we believe constitute the most important literature on concrete construction—the most important because it is most timely and because it couples the authority of men who know with the brevity which appeals to busy men.

Brains "In The Mix"

CONCRETE is unique among structural materials in that it involves in its use not only structural problems, but many and varied problems of factory and shop. To the casual observer, concrete construction may seem simple—build the wooden forms and fill them with steel and concrete. But stop and analyze this. In steel construction, the units come onto the work fabricated, ready for assembling. Their structural strength is accurately predetermined. Brick and tile are factory made units. Timber, as a structural unit, has been built up by nature, cell by cell.

Of all the materials of construction, concrete alone is manufactured as well as assembled in the field. The two operations are simultaneous. The entire structural efficiency is actually determined in the field. The position of the steel in a beam determines the neutral axis, and to some extent the tension values. The man behind the mixer holds in his hand the unit compressive value of the concrete. The man on the floor spading is determining the flange depth and T-beam efficiency. The field handles the component raw material, and the problems of manufacture and erection are one.

On the men supervising and conducting these processes, a great responsibility rests, and they must be trained to understand the work before them. Concrete construction is not a trade. It cannot be successfully picked up by serving an apprenticeship, as the other structural lines can. The successful concrete constructor must have an

understanding of the structural principles which are within and behind the work he is doing every day. And this understanding can be secured only by a technical training in the engineering principles involved. This training may be elementary, but it will be directed at the work the man is actually doing. Field experience can show a man *HOW* to do things, but technical understanding alone can show him *WHY*.

And the object of this: Only to impress upon the men in the field, on building work, or in concrete products plants the necessity of understanding *what* they are doing, and *why* they do it. The men who are actually making concrete should take every opportunity to study their work and keep in touch with the details of the best development in their field. Concrete must be mixed with brains.

The New Year

The mental effect wrought by the beginning of a new year should be less in the direction of a review of past achievements than in the line of new resolves. Yet we may use the past upon which to build those resolves. Thus we are impelled to remark that business generally is getting out more into the open. We shall not hasten to say that the business structure of today is being designed after ethical and moral formulas solely because of an awakened spirituality. We are sure that the awakened spirituality has come, but we feel that the development of keener business acumen is at the bottom of much of it. We may not have set down in our specification that we shall do the right thing, the big thing, the thing that is open and straightforward because such a course will be the best for the other fellow. We may not be so altruistic. Yet nowadays business is being conducted on those broad lines because they are best for the business so conducted. Not without much travail have we learned that honesty is the best policy, and more, that it is not enough to skimp through on a basis of mere honesty. Business has discovered that Service is the word—that Service given in a measure beyond that which is paid for, is bread cast upon the waters, and the new business ideal gathers strength now and then in the discovery that some

scanty crusts return as loaves. We find the ethical way and the practical way lying close together.

A Business Secret

Another thought pushes to the front in this same company. In fact it is the thought which prompted this New Year reflection. Business is learning that there is no such thing as a trade secret. The idea is obsolete. The men who are making their own way most successfully are making the other fellow's way easier. The only secret of success is an open secret and it consists mainly in mutual service. Were this not true this magazine could not exist. It must be perfectly plain to everyone that the men who edit this magazine could not discover, first-hand, the information about the use of concrete which it is possible to publish each month. The business of editing is a specialized occupation—an occupation followed with success when the editors know the men who know, and are able to offer in presentable pages of print the things which these *men-who-know* give out of their experience. Not an issue of this magazine goes into the mails, in which some readers are not introduced to the business "secrets" of other readers who may be their close-at-hand competitors. If you have not thought of this before, it will seem very remarkable. It still seems very wonderful to us, here at the center of this bureau of exchange. Yet it is an everyday matter. It is the new spirit of business. It is not due to an unwise generosity. It is partly due to the desire of every man who does a good piece of work to let that work have the widest possible influence in the field of work of which it is a part. Yet most of all it is due to a keen business sense—a keen business sense of a very high order which lies close to altruism.

In the last year a successful man in this field, a man who has devoted many years and many thousands of dollars to the development of a certain line of work, making that particular line more successful than ninety-nine out of a hundred have made it, a man whose business has been supposed to involve some "secrets," disclosed to one of the editors of this magazine much of the how and why of his work and made the statement that he would gladly show

a prospective competitor anything about his business which could be shown and tell him anything he had learned and help him in every possible way to get started. This offer was made without any swagger. The man said he thought such a course was good business. He said he would have been glad many times to have had other men entered upon a competitive enterprise because together they might sooner have educated the public. He pointed out that every bad piece of work done anywhere in his line hurt his business and every good piece of work helped his business. And there is the whole secret of the exchange of business "secrets." Every good piece of work done by your competitor creates favorable impressions of incalculable value—values which spread and grow. Your competitor cannot do you more harm than to fail in that line of work in which you are both engaged. Looked at broadly and upon a permanent basis, you cannot rise by his failure, so surely as by his success. Successful work is a permanent advertisement for that kind of work, when the name of the man who did it has been forgotten. These successful men of the field who tell you what they know—it is they who have the broad outlook; it is they who have discovered the real meaning and reward of *service*.

Beautiful and Permanent

On the grounds of the San Diego exposition, to be held in 1915, a great concrete viaduct is being built. When the ability, energy and money of exposition builders are used in making permanent concrete structures, a monument is left to posterity as a reminder of what has been done. A great improvement usually needed is left to the community for present and for future use. The outstanding feature in such an application of concrete is the manner in which it drives home the fact that concrete is architecturally beautiful as well as economical. Too long have steel structures been allowed to make a farce of viaducts for enduring highways. For graceful, economical and permanent viaducts, concrete is the true material. An article elsewhere in this issue describes and illustrates various details of construction of this character for the San Diego Exposition.

Tufa Concrete, Steel Forms and Efficient Equipment in House Construction

The last few years have seen a great many developments in construction details making for lower cost work in house construction. Rather an ingenious development in this line has been recently worked out by A. W. Gregg, a building contractor of Phoenix, Arizona.

The form here, as shown in the accompanying sketches, is essentially a rolled steel plate as shown in section in Fig. 1. These rolled steel panels are of different lengths and widths and have a lip rolled on one edge and a groove rolled on the other. On the work described in the accompanying notes, they were used in 2-4-6-9- and 10-ft. lengths and were 4½", 9" and 18" in width. The panels 18" in width are reinforced with a rib in the center. For corners the plates are rolled at an angle as shown in Fig. 2. This can be, of course, rolled to any angle required although the usual angle is 90°.

For tying the walls together there are holes bored just back of the lip in each end of the panel. These holes are bored 2' o. c. To hold the forms together wires are used which are twisted around the panel joint as shown in Fig. 2, using a concrete spreader. It isn't necessary to run the wires through the spreader, and in fact any spreader could be used following usual column centering practice.

For floor work, false work is put up with 4-in. x 4-in. timbers as ledgers and vertical shores. On top of this false work the panels are laid with the lip side down. For column work 4 angles are used with the necessary vertical panel in between. For beams practically the same method is used in applying the

panels as for the columns, although, of course, only two angles are used.

TUFA CONCRETE USED

The accompanying photograph shows some work recently completed in Phoenix. The aggregate used for this work is tufa, which is a white volcanic ash about half as heavy as sand or gravel. When it is used with cement it makes a light but very strong concrete. It is also a very good insulating material as it is a non-conductor of heat. This makes it a very good building material in warm climates and in floor construction it is unexcelled on account of its light weight and strength.

The accompanying illustrations show one of several cottages on which these forms were used recently. These cottages have five rooms and two porches. All the walls, floors, ceilings, and roofs are of tufa concrete.

NOTES ON CONSTRUCTION WORK

In handling the work a derrick was used for hoisting the material. This was a straight arm type mounted on the back of a heavy engine truck. This derrick is about 33' high and the horizontal arm carrying the traveling bucket was about 40' long. The derrick was supported with 5 guy wires long enough so that the arm of the derrick could swing over the farthest wall with a bucket full of concrete and deposit its load without interfering with the guy wires. This derrick, with the traveling carriage for the bucket is shown in Fig. 3.

When stripped, the walls were found to be in perfect alignment and free from pockets and air bubbles usually found in walls where wooden

forms are used. On account of the smoothness of the forms the concrete settles rapidly and consequently requires little puddling. In addition to this the forms being water-tight, the concrete was run in a thin muck.

The forms were set for this cottage in 10 days with 4 unskilled laborers. The concrete was poured in 15 hours with 8 men. The cottage on which these forms and tufa were used cost less than the same sized building in brick with a shingle roof. The door and window frames present some interesting features being of pressed galvanized metal as shown in detail Fig. 6. These window frames are in two parts; the outside part provides a place for the weights to run in and is placed between the forms before the con-

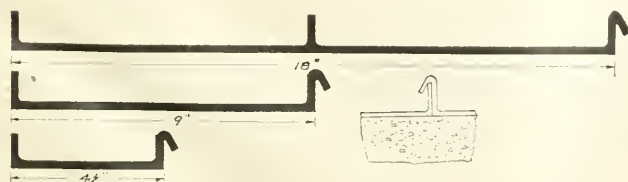


FIG. 1—DETAILS SHOWING THE STEEL FORM IN SECTIONS

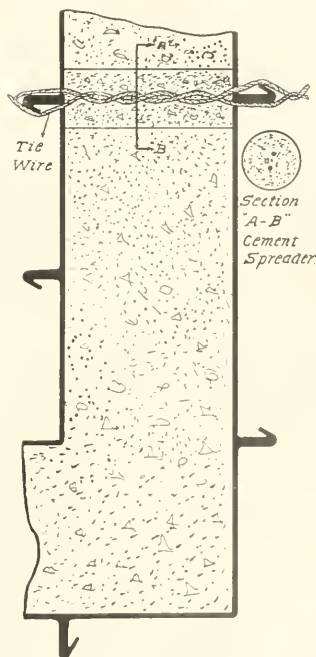


FIG. 2—DETAIL OF WALL SECTION SHOWING APPLICATION OF STEEL FORMS



FIG. 3—THE COTTAGE UNDER CONSTRUCTION

This shows the steel forms; the derrick is shown in the background



FIG. 4—STEEL FORMS IN PLACE READY FOR A FLOOR

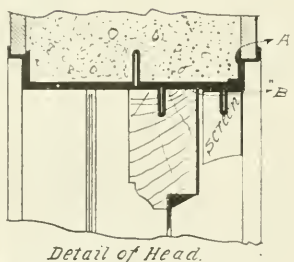
The reinforcing steel is shown in place

crete is poured (a of Fig. 6) then the inside parts which hold the sashes in place after the forms are removed, (b of Fig. 6).

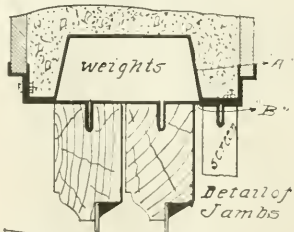


FIG. 5—THE COMPLETED COTTAGE

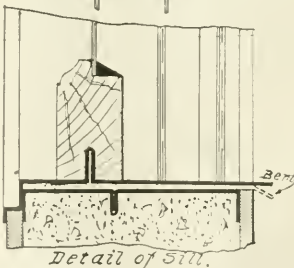
The derrick above referred to was used largely for hoisting the material. In construction it is a straight-arm type and as used was mounted on the back of a heavy engine truck. It, of course, can be built any height desired, but as used was 33' high. The horizontal arm carrying the bucket is 40' long. The derrick is supported by five guy wires of sufficient length to permit the arm of the derrick to swing over the farthest wall with a bucket of concrete and deposit its load without interfering with the guy wires. The travel is controlled by the engineer in charge of the gasoline engine (used for power) by signal from the man on top of the building. The derrick be-



Detail of Head.



Detail of Jamb



Detail of Sill.

FIG. 6—DETAIL OF WINDOW FRAMES USED

ing of a square arm type permits the bucket to be raised to the top of the wall and then its transportation to the point where the dump is to be made. It is, of course, apparent that the great advantage to be gained is having the concrete go directly into the bucket of conveyance from the mixer and then poured into the forms. As used, the bucket was emptied through a trap bottom of a style permitting the pouring of any part of the contents of the bucket. The bucket carried 8 cu. ft. of concrete. The hoist and derriek handled from 25 to 30 per hr. and could have handled more had the mixer been able to supply the material. The construction of the derrick is shown in the attached drawing.

Altogether the construction methods describe present features of more than usual interest. The horizontal-arm vertical-mast derrick, with a traveling carriage for the concrete bucket, suggests a rather efficient rig for this work, especially so since the same outfit could be used to handle heavy panel forms.

The Tidewater Portland Cement Co., Union Bridge, Md., will add to the electrical drive equipment in its mills three 15-h.p., two 25-h.p. and two 100-h.p. induction motors recently ordered from the General Electric Co.

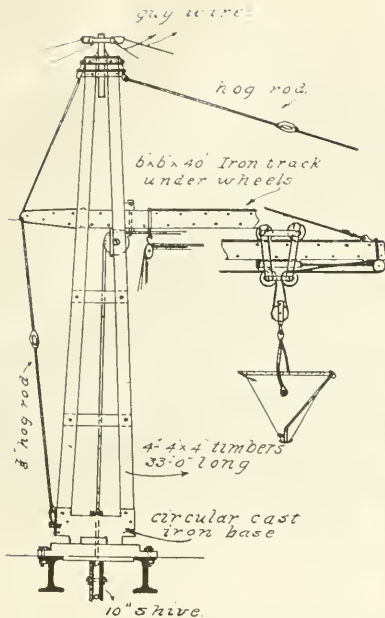


FIG. 7—DETAIL ELEVATION OF MAST AND BOOM USED FOR HANDLING CONCRETE AND STEEL FORMS



FIG. 8—THE PLANT USED IN BUILDING TUFAL CONCRETE COTTAGES, MIXER, CRUSHER AND DISTRIBUTING MAST AND BOOM

Scottish Infirmary Built of Reinforced Concrete

Among the many recent public buildings built in Aberdeen, the Royal Infirmary is one of considerable magnitude and architectural merit. This Infirmary, founded 175 years ago, has had a long and useful life. In the many years of its existence it has been rebuilt and added to. Of interest at present are additions made since 1911, in which time three new operating theatres of all reinforced concrete construction have been added. The accompanying illustrations are typical of the interior construction and shows the central corridor or waiting hall.

The floor slabs and the ordinary flat roof slabs are 4" thick supported by beams usually 5" wide, and 10" and 12" deep. The roof over the waiting hall shown in the accompanying illustration is formed by a series of arched reinforced concrete girders 12' o.c., 18" wide by 72" deep at the spring line and 21" deep at the crown. The beams between these arched girders are 5" wide and 8" deep.

All the reinforced concrete work was carried out by James Scott & Son, Aberdeen, in accordance with the designs of the architects, Kelly &

Nicol, for whom details of the reinforced concrete construction were prepared by L. G. Mouchel & Partners, Westminster and Glasgow.



INTERIOR OF THE CENTRAL CORRIDOR AT THE ABERDEEN INFIRMARY



FIG. 1—KENNEL BUILDING WITH CAPACITY FOR 1,000 HOUNDS—CONCRETE THROUGHOUT EXCEPT ROOF

The Use of Cement Grout and Field Stones in Interesting and Economical Construction

BY CLAUDE H. HAGA

Portland cement grout and ordinary stones gathered from the fields have been used in a satisfactory, interesting and economical construction in a large amount of work on the estate of Joseph B. Thomas, at Middleburg, Va. The designs for the various works were furnished by Frederick J. Sterner, Archt., N. Y.

C., and the construction was in charge of Claude H. Haga, Supt. of Buildings for the estate. In the description of the work published here, Mr. Haga mentions more particularly the wall which surrounds the property, but he also furnishes information on the construction of various buildings and other work.

It was desired to enclose portions of the estate of Joseph B. Thomas, Middleburg, Va., with walls of an interesting type which would age attractively, and at the same time erect them in a permanent manner. This section abounds in stones that lend themselves to many systems of construction. We had some stone walls built in the usual way but found that such construction required a wall at least 18" thick and of assorted stone, with skilled mechanics to build them.

We then made various experiments with steel forms¹ in sizes 24"x24" and 12"x24" with very gratifying

results. We found a 12" wall the most satisfactory as it eliminated the necessity of so many abutments and we were able to use stones of almost any size in them. The method of construction that we finally adopted here is as follows:

First, a trench 2' 6" wide and 18" deep, is dug; across this trench we lay timbers 1"x3"x4' about 8' apart; these timbers support the forms; after the forms are put up we level them where necessary by blocking up the timbers; then we proceed to fill the trench and forms with grout; we are thus able to get a continuous pour for both footing and wall, and eliminate the difficulty of getting a bond between walls and footings.

We have no waste of lumber in our footings and our levels are easily gotten.

Our abutments are made by using the perforated plates and corner pieces with a wood cut-off placed at an angle inside of them.

Nearly all of our walls so far have been built on hillsides and required footings and copings to be stepped in terraces.

The 12-in. x 24-in. plates are used more considerably in this work. As the ground rises we replace our 24-in. plates with 12-in. plates until the bottom of the 12-in. plate reaches the ground, then we step on top of it with 24-in. plates and proceed until our 24-in. plates reach the ground; then we use the 12-in. plates again. The levels at the tops of walls can be placed wherever the fancy desires by putting in wood cut-offs or by keying a perforated plate across the ends of regular wall plates.

Inasmuch as we stucco the walls afterwards we find a material saving of time and labor in using loops of wire and 12-in. wood sticks in place of the iron pipes ordinarily employed which have to be removed,

¹Made by Read & Morrill, Inc., Brooklyn



FIG. 2—POWER HOUSE

leaving holes to be pointed up. These wire loops can be accurately made over a 12-in. block so that the keys draw the forms against the 12-in. wood sticks that are used in place of the pipes. This is especially desirable at the bottom of the first course of forms as it is troublesome to remove the pipes that rest on the footings.

The copings are put on afterwards; we make them in wood forms, using a great variety of colors in our mortars.

The stucco is composed of white cement, lime paste and pulverized white flint stone as follows:

- 1 part white cement.
- 1½ parts rock lime paste
(2 wks. old).
- 2 parts white flint.

We have our own crusher and there is a great quantity of white flint here.

We plaster the stucco direct on the walls, about ¾" thick. Care is to be exercised in seeing that the wall is somewhat rough before applying the coating. We obtain this roughness by coating the inner face of the steel forms with rosin and sand; this can easily be removed from the forms by heating slightly when they are to be cleaned.

HAND MIXING USED

All our mixing has been done by hand. We have sled runners on our mixing boards and portable scaffolding. In this wall work we have used all kinds of stone, principally the stones gathered from the fields on the estate. They are dropped into the forms from the wagons; but they should always be dropped and im-

mersed in the mortar and at all times the mortar should be placed prior to the stone. The practice of pouring mortar over the stone leaves pockets and defects. We use as many stones as we can immerse and use no care whatever in placing them. In erecting 950 cu. yds. of this wall we have not had a single crack or defect. The same wall in stone would have required an 18-in. wall of select stone,



FIG. 3—RESERVOIR OF CONCRETE TO HOLD 65,000 GALLONS

laid by skilled mechanics and at an increased cost of at least 30%, and at the same time we would have failed in getting the ancient stucco effect we desire.

The cost of this wall will vary in localities and with conditions. Here we have an abundance of stone but sand and cement have to be hauled some distance. Labor costs 19½ cts. per hour. It is necessary to haul water to the board.

The costs per cu. yd. on a wall of 69 cu. yds., erected on a level grade are shown as follows:

1 yd. field stone at 60c. \$.60

¾ yd. sand at \$1.50.	1.12
300 lbs. cement at \$1.50 bl. . .	1.12
100 lbs. lime.	.48
Excavating	.06
Mould setting	.08
Mixing and pouring.	.75

\$4.21

The stucco cost about 10 cts. per sq. yd.

The copings and setting cost about 9 cts. per lin. ft.

Our walls have an average height of 7' above grade, but for general purposes of enclosing fields, lots, yards, etc., from 4' to 4' 6" would probably be preferable and for such walls the thickness could be reduced to 6" by adding a few more abutments, thereby making it altogether possible to replace stone fences and other materials with concrete walls on a commercial and practical basis.

A general view of the kennel building on the Thomas estate is shown in Fig. 1. This was erected with steel forms by the grout or poured process. It is entirely fire proof except for the shingle roof. All walls and floors are of reinforced concrete, varying from 8" to 12" in thickness. It has every modern convenience; hot water heat, plumbing, drainage, cold storage and keeper's apartment. All pipes are concealed within the walls; shafts to contain them are provided by placing terra

cotta tile in the forms and the concrete poured around them. Every floor has drainage and every room sewer connections. The total area covered by the building and outside courts is 125'x375'; the building proper 110'x125'. It has cold storage, general storage, fuel, furnace and laundry in the basement. In its construction, 2,625 bbls. of cement were used. The total cost was about \$41,500. It has a capacity of 1,000 hounds, and is considered the most modern and best kennel building in the world.

The power house is shown in Fig.



FIG. 4—BRIDGE OF REINFORCED CONCRETE WITH UNIQUE SURFACE EFFECTS

2. The walls are 12" thick, and heavily reinforced. Stones of all sizes were used, some as large as could be placed in the forms. The walls are absolutely perfect; the vibration from engine, dynamo and other machinery has not brought out any defects. The walls in this building cost slightly less than \$6.00 per cu. yd.

In the foreground of the illustration is shown a part of the receiving basin that holds 30,000 gals. of water. The walls for this basin are 12" thick; crushed stone were used in this. The cost per cu. yd. was about \$6.10, including dressing the inner sides of the walls. The water supplying this basin is piped by gravity from a large spring $\frac{5}{8}$ of a mile away; from the basin it is pumped to the reservoir.

Neither power house nor basin has been completed; i. e., dressed or stuccoed.

The reservoir is shown in Fig. 3. It has a capacity of about 65,000 gals. Its walls are 3' thick at base and 2' at top. It is heavily reinforced and was constructed with stockades.

It is finished in white stucco; quarry stone of all sizes were dropped in the grout.

Ice formed over it several times in the winter of 1912-13, and it is usually kept full of water, but no defects of any kind have appeared. The coping and rim are in one solid cast and were dressed, while quite green, in colored concrete of various tints. About 880 bbls. of cement were used in its construction. The total cost, while confused with other

work at the time, was approximately \$4,200. The power house supplying it can be seen in the distance in the illustration.

A bridge on the estate is shown in Fig. 4. The same steel molds were used in connection with wood stockade forms. It is all solid concrete work with brick veneered pillars and arch.

The brick spots showing here and there are an effect obtained in two ways; one by laying bricks inside the forms and pouring around them; the other by plastering in red cement stucco with mortar joints cut while wet, then pointing up as we would a regular brick wall. The white stucco is applied so as to appear as if the bridge were originally of brick and stuccoed over, with some of the stucco falling off. The general appearance is very interesting and quaint. In its construction 750 bbls.

of cement were used, not including that used in the stucco or copings. The cost was about \$3,700, not including grading and filling, a part which is not yet completed.

In Fig. 5 is seen the entrance to the estate in which two poured cottages are used as elements; one for a gatekeeper and one for a lodge. Steel forms were used altogether except for erecting some bent wall work that does not appear clearly in the plate.

These cottages were constructed on two altogether different lines. The one on the right was erected by a careful grading of crushed stone, sharp sand and cement and some reinforcing. We used a carefully gauged mix of 1:2:4 and gave it an almost smooth finish in white stucco. The walls are 8" thick.

On the other we made our walls 12" thick and used no reinforcing



FIG. 5—BUILDINGS AT ENTRANCE TO THOMAS ESTATE



FIG. 6—GARDEN WALLS BUILT IN TIGHT FORMS WITH GROUT AND STONE

at all except around some gable windows. We used 1 part cement, 2 parts sand, and $\frac{1}{2}$ part hydrated lime, made a thin mortar of it and after pouring it in the forms we immersed all the stones we could possibly get out of sight into it; we used any and all sizes of stones, some weighing probably 20 lbs. to 25 lbs. We used no care except to keep the stones lying flat. We finished it like the other except that we left the surface rougher at the owner's choice. The cost of area enclosed was decidedly less in the second cottage although the walls are one-third thicker. No defects have appeared in either cottage.

The costs are impossible to determine correctly in either case, as both

houses were erected in connection with the entrance, side walls, pigsty, chicken houses, etc.

Each house has seven rooms, bath and porches. The first one, and other work connected with it are about similar in quantity to the second, while the total cost was considerably less on the second one. The cost was about \$2,700 for the first and the second about \$2,450.

Fig. 6 shows two views of the grout and stone garden walls. This type of wall is being used in enclosing the estate and for other purposes. It varies from 7' to 9' above and 18" below grade, and is 12" thick above and 2' below grade. Abutments are added more for appearance than because they are

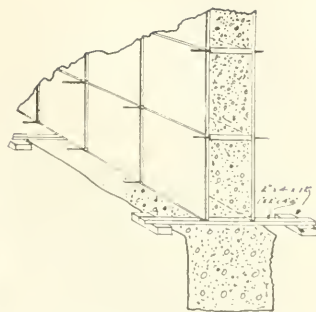


FIG. 8—DETAIL OF WALL AND FOOTING CONSTRUCTION

needed. About 800 lin. yds. have been built.

I do not think the 100 lbs. of lime used in the composition given in my previous letter would be satisfactory in a wall of a different kind, such as a retaining wall or a wall that had any great weight to carry, but I found it entirely satisfactory in these estate walls. I would probably reduce it to 50 lbs. in an 8" wall, and to 25 lbs. in a retaining or carrying wall, but find the use of some lime very satisfactory in nearly all cases where we wish to remove the steel forms rapidly.

The walls in which 100 lbs. of lime were used were all 12" thick and averaged 7' above grade; 18" to 24" below grade, with a footing width of 24" to 30" according to the soil.

Reinforced Concrete is Used More Extensively in India

In surveying trade conditions in Bombay and India in general it was noted in a recent issue of *CONCRETE-CEMENT AGE* that building stone has risen in price and that teak wood, which has been the staple building material in India for centuries, has also undergone an abnormal increase in cost. The report goes on to say that cement has increased 34% in quantity and 52% in value in the last year and that reinforced concrete structures are now seen in many sections of Bombay and are likely to be the base of all new structures such as tenements, warehouses, etc.

So it goes round the world and engineers, architects and builders are having the same experience that we have had here in past years. Reinforced concrete is the building material.



FIG. 7—TWO SMALL BUILDINGS OF CONCRETE ON THOMAS PROPERTY

A Concrete Arch Bridge at the San Diego Exposition— Beautiful and Permanent



FIG. 1—ARCHITECT'S PERSPECTIVE OF THE COMPLETED BRIDGE

A combination of beautiful but simple architecture, and a wonderfully instructive revelation of things that man is doing and how he is doing them, how he lives, and how he earns his livelihood, with striking comparisons of the difference between human aspirations and processes used in this and in bygone generations, will make the San Diego exposition in 1915 different, and the visitor will find much of interest, pleasure, instruction and inspiration. The California State building, the Ethnology building, the Puente Español, the great bridge over Cabrillo Canon forming the west entrance to the grounds, are of reinforced concrete. Of these structures the most striking is the Puente Cabrillo. It will be a seven-arch bridge with enclosed beam and girder approaches. At either end there is an earth-filled retaining wall. These walls are of the "box" type, the sides being reinforced slabs 12" thick tied together with steel rods bedded in concrete. The end wall of this section is of the buttress type. The two buttresses serve not only to take the overturning thrust of the earth fill, but also to carry the ends of the concrete girders of the approach spans.

STRUCTURAL FEATURES OF THE BRIDGE

The east approach consists of two roadway girders, 24' c.-c., each 2' wide x 4' deep, and 144' long, supported by columns 24' c.-c., and two smaller girders at the edge of the

sidewalk, with transverse floor beams 8' c.-c., carrying the floor slabs. The parapet wall along this section is carried to the ground, completely enclosing the girders and the supporting columns. The west approach is a similar section 72' long.

The bold and unusual features of this bridge are in the section between the two approaches. To the casual observer, the structure will have seven arches each of 56-ft. span with piers 12' wide. A closer inspection, however, will reveal expansion joints at the crown of each arch. This design limits the effect of temperature changes to the portions between the crowns of adjacent arches. To do this the bridge was designed not as a series of elastic arches, but as a series of balanced cantilevers resting on the piers.

The roadway slab is carried on transverse floor beams and the sidewalk slab on 6-in. diaphragms which also tie the roadway and the sidewalk cantilevers together.

The roadway cantilevers rest on reinforced columns. The sidewalk cantilevers are carried to the foundations as a reinforced section 15" wide and 12' long.

To stiffen the structure and more completely to tie the roadway and the sidewalk cantilevers together, a 6-in. soffit is indicated between the roadway and the sidewalk cantilevers. The pier is 41' 8" wide but at this section is divided into two parts,

which are connected by a transverse arch. The piers below this section are stiffened by horizontal diaphragms 8" thick and 15' c.-c.

The reinforcing of the 6-in. and 8-in. diaphragms consists of a double system of diagonals, usually of 1½-in.

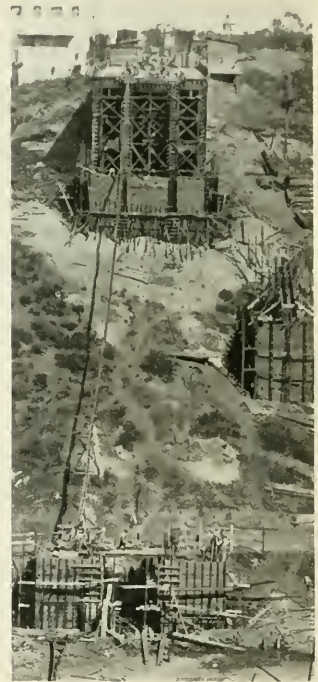


FIG. 2—PRELIMINARY WORK AT THE EAST APPROACH OF THE SAN DIEGO BRIDGE

In the foreground is shown the work in some of the central piers. At this time concrete was being chuted from the mixer at the east approach, shown in the background. This plant is shown in the center of Fig. 6. The bins for holding sand and stone for the main mixing plant are shown at the right. Note the diagonal reinforcing in the face of the pier wall

rods spaced 24" c.-c. The floor slabs are reinforced with Kahn shear bars, floor beams and girders are reinforced with ¾-in. bars and 1-in. bars. All steel for the bridge is being furnished by the



FIG. 4—GENERAL VIEW OF "PUENTE CABRILLA" UNDER CONSTRUCTION AT THE SAN DIEGO EXPOSITION. AT THE EXTREME LEFT IS SHOWN THE GRAVITY TOWER

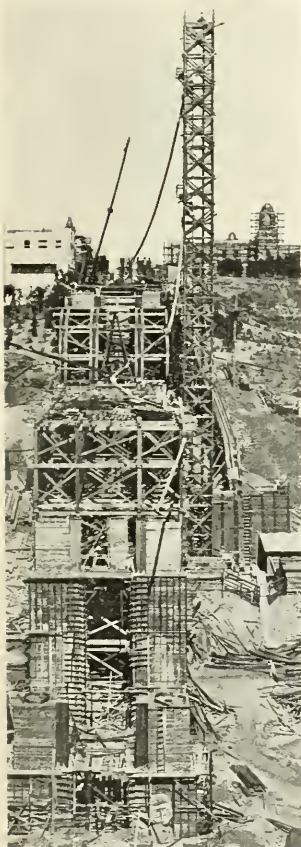


FIG. 3—THIS SHOWS VERY MUCH THE SAME VIEW AS FIG. 2, WITH THE WORK FURTHER ADVANCED

In this view the central tower for handling concrete has been built and is in operation. Work has been begun on the intermediate piers

Trussed Concrete Steel Co., Detroit. There will be used in the construction of this bridge 7,700 cu. yds. of concrete and 450 tons of steel.

CONSTRUCTION METHODS

The necessity for economy in costs necessitated the introduction of automatic methods as far as possible. In handling the materials for the mixture and the concrete after mixing, a system of chutes was devised, supplemented by a hoist at a central point from which to pour the entire structure.

Auto trucks bring the sand, rock and cement to a dump bin on the end of the east abutment. Two chutes carry the sand and broken rock to separate bins in one structure at the base of the center pier. The cement is also stored here. The bins open

by a gate at the base operated by a lever that raises the gate to each bin and admits the proper amount of sand, rock and cement to a common hopper which in turn dumps the material into a 30-cu. ft. mixer, the water being supplied from a pipe let into the mixer itself. The mixer dumps with a lever into a hoist or "skip" operated in the 200-ft. scaffold built to carry the hoist with its lead, at the rate of 100' per sec. The skip dumps automatically into a hopper at the required elevation in the scaffold and the mixture falls into a sheet iron chute suspended on a $1\frac{1}{2}$ -in. cable, the chute leading to that portion of the structure at which it is desired to dump the mixture.

Two men handle the materials and the mixer at the bottom of the scaffold. One man operates the hoist-



FIG. 5—DETAIL VIEW OF THE EAST APPROACH

This shows in detail the walled-in approach span



Fig. 6—Running the Bridge Floor on the San Diego Work

This is a detail view of the east approach. Of special interest is the use of sectional platform runways for the concrete buggies

ing machinery. One man attends the hopper at the top of the lift. Tampers attend the outflow.

With this device a batch is placed every 2 min. The segments of the cantilevers require 30 hrs. of continuous pouring. All of the work of designing and constructing the exposition's many structures is being done by the Division of Works,—Frank P. Allen, Jr., Dir. All construction work is being carried on by force accounts.

OTHER CONCRETE STRUCTURES

Many other permanent structures planned by the exposition will be built of concrete. The California building at the east end of the bridge, with its tower rising 180' above the level of the bridge floor, will be built of reinforced concrete.

Concrete is being used in the construction of the sanitary and the storm water sewer systems as being the most economical material for this purpose.

An Interesting Water Tower Near York, England

The accompanying illustration shows an unusual type of water reservoir constructed by the Yorkshire Hennebique Contracting Co., Ltd., Leeds, Eng., near York, from the designs of L. G. Mouchel & Partners.

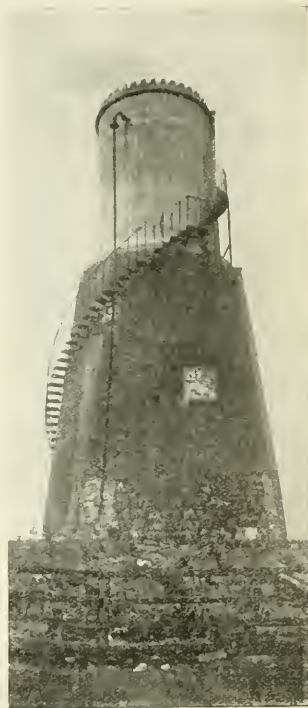
The object of the structure is to provide for the storage of some 25,000 gals. of water to be used as domestic supplies and for farm and stable purposes. The main portion of the tower was formerly part of a windmill, but is now lined with reinforced concrete so as to form a perfectly water-tight chamber. The upper portion is a cylindrical chamber built entirely of reinforced concrete, the upper and the lower reservoir being separated by a floor of the same material.

Water is delivered by pumps into the upper or high pressure reservoir, the capacity of which is 9,000 gals., and the lower reservoir, capable of containing 16,000 gals., is served by an overflow pipe fitted in the center of the chamber above. Each compartment is provided with a 4-in. delivery pipe and valve so that sup-

plies can be drawn off as required. The top of the upper reservoir is covered by a reinforced concrete flat roof, to which access is gained by means of the spiral stairway shown in the illustration.

Standing on high ground and rising to the height of 30', the tower of the old windmill appeared to offer an excellent and ready-made support for water storage tanks. The original intention probably was simply to install cast iron tanks on the top of the tower after removal of the mill fittings, and that the proprietor afterwards decided upon the adoption of reinforced concrete as a more economical material, of greater durability than metal, and offering the further advantage that being quite unaffected by corrosion it would require no painting or maintenance charges of any kind.

The design prepared by Mouchel & Partners exhibits features of decided originality, for instead of merely utilizing the old masonry tower as a support it provided, as already stated, for converting the interior into a low-pressure reservoir, thereby effecting a very considerable reduction in the cost of the works.



AN OLD WINDMILL NEAR YORK, ENO., CONVERTED INTO A MODERN REINFORCED CONCRETE WATER TOWER

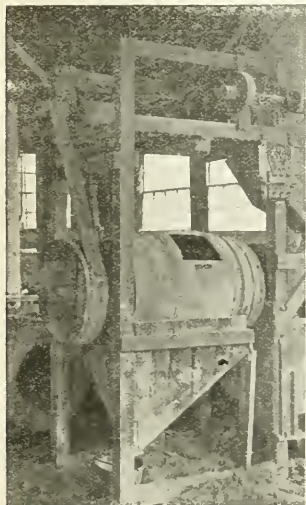
A reinforced concrete floor at ground level forms the basis for a thin monolithic casing of reinforced concrete carried around the interior walls and covered by a circular floor, upon which is built the high-pressure cylindrical reservoir with walls 6" thick, rising to the further height of 18', and finished by a castellated parapet 3' above the flat roof.

A Home-Made Mixer Made of a Barrel

In the plant of the Trusswall Mfg. Co., Kansas City, Mo., the barrel mixer shown in the accompanying illustration is in use. This was built over three years ago and at a time when the market was not so well supplied with small mixers. The following notes, from G. E. Higgins, Gen. Mgr. of the company, describe the essential features of this equipment:

A large barrel was secured and the heads put in firmly, a hole cut in the side and a door made and some pieces of wood put inside the barrel lengthwise to break up the material, and the mixer was made. A pair of flanges on the ends of the barrel clamped to the shaft was used to carry and revolve, and a pulley on the shaft to drive with a $1\frac{1}{2}$ h. p. motor. It was found that a speed of from 18 r. p. m. to 20 r. p. m. is about right.

This mixer is used for mixing finishing material of various kinds, and also for mixing the colors for colored work. Batches up to 400 lbs. are mixed at a time, but that makes a hard pull on the belt. To empty, the door is taken off, and the barrel revolved a few times, when it empties into the hopper below. The frame was made high with the intention of elevating and screening the material and also to get the motor out of the way, but later, securing the materials of the right grade, the elevator and screen were discarded. This mixer has been in use two years and gives the best of satisfaction.



A HOME-MADE BARREL MIXER IN A CONCRETE PLANT



FIG. 1—CONCRETE SNOW SHEDS IN THE CASCADE MOUNTAINS

At the right can be seen the centering in place for the main back wall of the shed. In the foreground footings are being placed with a hand mixer

Concrete Snow Sheds in the Cascade Mountains Built by Great Northern Railway

In the season of 1913, the Great Northern Ry. built 4,000' of concrete snow sheds to protect its line from snow slides. The work described in the accompanying notes and illustrations is located on the western side of the Cascade mountains on the main line of the Great Northern Ry., near the location of the Wellington slide, where a train was caught in a slide a few years ago.

These snow sheds are being built in places where the timber is badly burnt off and where slides from 40' to 75' deep took place last winter. This particular year snow fell over 30' deep on the level.

Owing to the fact that it is a single track main line and on a mountain division it was impossible to erect all the concrete sheds desired on account of inability to get material in fast enough. Therefore about 25,000,000 ft. of timber were used in erecting timber sheds in addition to the concrete. Sheds are not all concrete: back walls and footings for posts are concrete and roofs and front walls are timber. In the past season, sheds were erected at three different places, the manner of handling mate-

rial and of construction being practically the same in all three. Typical work is shown clearly in the accompanying views.

HANDLING CONCRETE MATERIALS

Sand and gravel were all shipped in from about 100 miles away and cement came in cars in bags. The utmost difficulty was experienced in keeping the mixers supplied with material. In addition, the clearance between the tracks and the wall was so close that when a train was going by the loading skip of the mixer had to be in the lowest position. This clearance was only 15' and offered very little space to put material. On this road they ran freight trains of 60 cars and a great many times a freight train waiting for a block to be cleared would stop in front of the walls, tying up two or three mixers for from half an hour to an hour.

Owing to congested traffic conditions and the fact that being on a mountain division work trains had to carry staffs to work in the block, the mixers were running on half rations most of the time and a carload of cement had to be split up among the three camps.

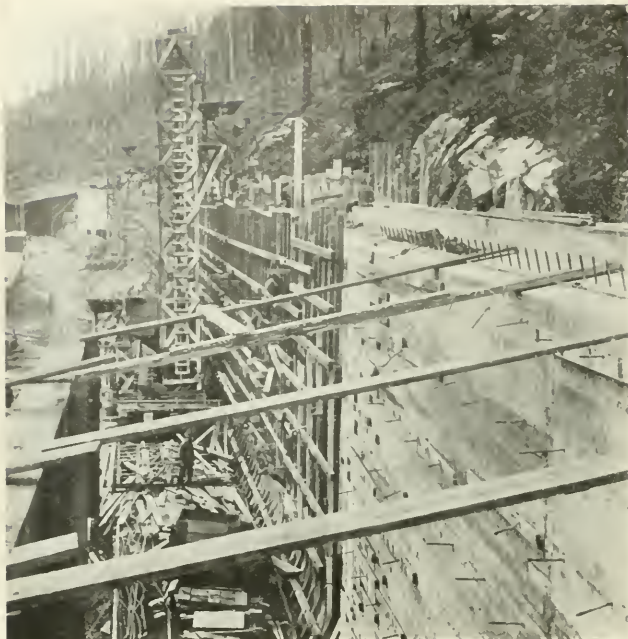


FIG. 2—A CLOSER VIEW OF CONCRETE SNOW SHEDS IN THE CASCADE MOUNTAINS

The distance from the first camp by the railroad to the third was about eight miles but by an air line down the hill about $2\frac{1}{2}$ miles, the lower camp being at an elevation about 900' lower.

EQUIPMENT USED

Each camp was equipped with three No. 12 Smith mixers¹ fitted with power charger and steam engine. Each mixer was on a movable platform on rails and used a 7 ft. x 10 ft. single drum hoisting engine to hoist the bucket. The boiler on the hoist also supplied steam for the mixer. Each camp also had two hoisting engines and derricks for wrecking the old snow sheds, a steam shovel and locomotive with cars to excavate where there were no old sheds. All the snow sheds are being constructed for double track. Each camp was also equipped with a hand mixer¹ to put in footings for the posts.

In order to finish in the short summer season that prevails in the mountains two shifts were worked, acetylene lights being used.²

The camps were the finest and

most sanitary ever erected in this part of the country. Running mountain water was available under pressure at all times, the food served was a great deal better in quality than is gotten in the average restaurant.

The engineer in charge for Guthrie McDougall & Co., the contractors, was J. C. Baxter, and the resident superintendent was H. J. King. The superintendent had to climb down and up the 900' once and sometimes twice a day. The great difficulty was in keeping the crews in material.

Labor was high and scarce and only the extraordinarily good camps and board kept any men at all. In the height of the season about 200 men were going and coming each day.

This work involved the placing of 56,000 cu. yds. of concrete, in which 70,000 bbls. of cement were used. One million feet of lumber were used for forms; 100,000 cu. yds. of excavation were made for the snow sheds, 70% of which was rock, and the back filling by means of steam shovels, dinkeys and cars was about 150,000 cu. yds. more. The first concrete was placed June 25, and the last Nov. 1.

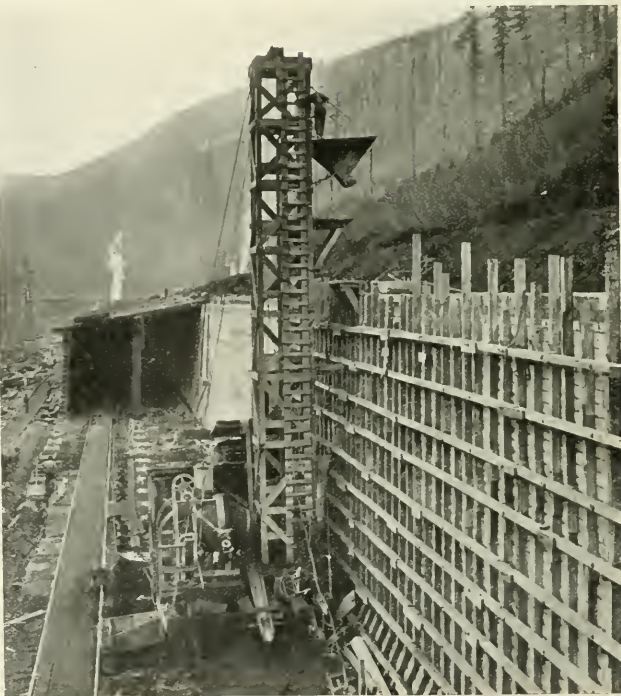


FIG. 3—DETAIL VIEW OF THE CENTERING AND ONE OF THE TOWER PLANTS

¹T. L. Smith Co., Milwaukee

²Alexander Milburn Co., Baltimore

The Construction of a Concrete Sea-Wall on the Lower Mississippi¹



FIG. 1—USING A LUMBER RIG TO HANDLE CONCRETE SHEET PILE

The municipality of Bay St. Louis, Hancock Co., Miss., has under construction a reinforced concrete tongue and groove piling sea-wall. This is being built in the immediate front of the city to shut out the wave wash incidental to the tropical storms that visit the coast periodically.

The accompanying sketches show in detail the piles used. They are rectangular in section, pre-cast on timber platforms, using 24-ga. galvanized iron for partitions. The piling is 21' long, 20" face and 9" thick, and is reinforced with two $\frac{3}{4}$ -in. bars the total length and with a 1-in. steel bar beginning 4' from the top and extending 12' downward. The piling is cuneiformed at one end so that while being sunken the toe penetrating first will by the parallelogram of forces hug the piling just placed. The groove is 3" in radius, and the tongue is $2\frac{3}{4}$ " in radius. The mixture is made 1:2 $\frac{1}{2}$:5, the sand used coming from the beach, and the gravel from Hattiesburg, 100 miles away. The piling was cast alongside of where it was to be placed. The maximum haul for the fin-

ished pile was 100', usually averaging, however, less than 50'.

HORIZONTAL CAPPING USED

The piling, when a 50-ft. section is placed, is capped over with an ornamental coping of very heavily reinforced concrete, 9" high and 16"

wide. This becomes an integral part of the wall. The piling, as illustrated, has two perpendicular bars extending $\pm 1\frac{1}{2}$ " above the concrete and a ring is turned on the top of each bar, through which horizontal bars of twisted steel are inserted to form the reinforcing necessary for the coping.

JETTING THE PILES INTO PLACE

Before being driven the piling is aged for 28 das. on the forms. They are then conveyed to their place by a log carrier, as shown in the illustration, where they are hoisted by a

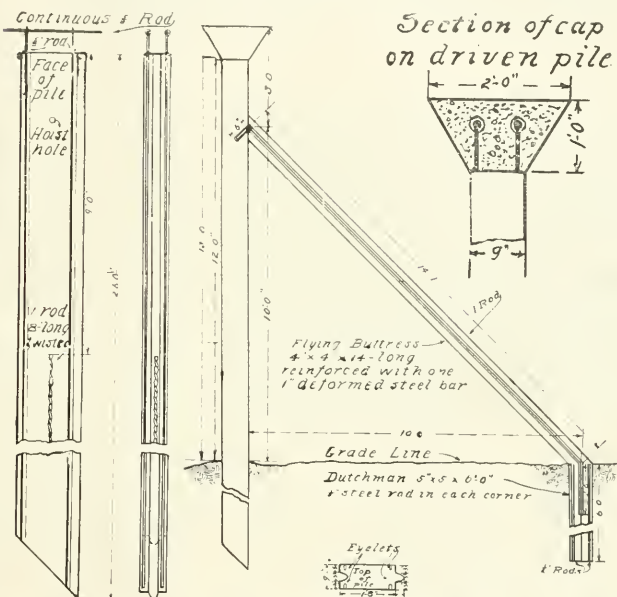


FIG. 2—SKETCHES SHOWING DETAILS OF SHEET PILE RETAINING WALL



FIG. 3—PLACING CONCRETE SHEET PILING

¹For the notes and illustrations in this work we are indebted to T. L. Trawick, Bay St. Louis, Miss.



FIG. 4—A SECTION OF A SHEET PILE RETAINING WALL, OUTER FACE

derrick under gasoline power—6 h. p.—and are lowered into position. The pump used by the contractor is not shown in the illustration but has a pressure of 60 lbs. on a 3-in. main leading down to a 1½-in. hose. Three nozzles play on the descending pile and the submerging is gradual. A stratum of blue clay is reached after the pile has reached a depth of 9' beneath the surface; the derrick then lifts the piling up several feet, allowing it to sink of its own weight until after several elevations it sinks to a distance of 13', leaving 8' above the datum plane. This, in the field, is commonly referred to as "churning" a pile into place.

Already 1,500' of piling has been constructed and a new contract is to be let for 8,000' more, covering practically the whole sea front of the city. The city is also contemplating pumping in silt from the sea to fill up behind this sea-wall and plans are now drawing asking the permission of the War Department to do dredging by centrifugals to pump the silt in.

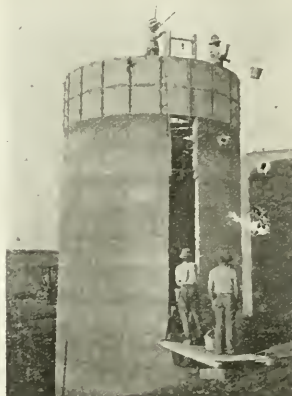
Fremont, Ohio, courts have a nice question before them in the matter of a suit for the recovery of the cost of a carload of cement shipped f.o.b. at Pittsburgh to a local cement company at the time of the flood last spring. When the car was shipped it was cement. When it got into water during the floods the usual thing happened and the cement turned to stone. The question for the court to decide is:—Whether the man who orders cement and gets stone is a winner or a loser, and whether the railroad, the water, the floods or the shipper is responsible for the loss, if any.

Building Concrete Silos in South Africa

American equipment is being used in concrete work right around the globe. In the newer countries of the world, especially, American methods take hold most strongly, and in South Africa, New Zealand, Australia and other countries, American mixers, forms and materials are the usual thing.

The accompanying illustrations show some silos built with steel molds¹ by H. A. Rogers, Johannesburg, South Africa. The concrete used here is a 1:3:4 mix, and ordinary fencing wire is used as reinforcement. For the horizontal reinforcement the wire is doubled and twisted. The cost of such a silo, 12' in diameter and of 100 tons capacity, is approximately \$125. This

¹Reichert Mfg. Co., Milwaukee, Wis.



A CONCRETE SILO BEING BUILT NEAR JOHANNESBURG, S. AFRICA

figure includes all costs and is considered remarkably cheap and by far the best value for the money expended.

In the view shown the work is 26' from the bottom. The full bucket of concrete is pulled up inside with a block and tackle. As soon as empty it is hooked on the wire and slid down to the mixing platforms. The men carrying concrete, after they have brought their full pail, start right back to the mixing platform without waiting to carry the empty pail back. Gravity does that work.

A New Ruling on Design Patents

An important decision has just been rendered by the Commissioner of Patents in regard to the payment of government fees in applications for design patents. Heretofore an application for a 17-yr. patent on a new appliance, machine or process required a government filing fee of \$15 only, while an application for a design patent running for the maximum term of 14 yrs. required a fee of \$30 to accompany it. Since the examination of applications for design patents as to their novelty requires much less time and study than that regarding the novelty of structural or process patents, Lotz and Scheible, patent attorneys, Chicago, call attention to the fact that this discrepancy has been unfair to those having ornamental devices which they wish to protect, for the government fees are not returned if the application is rejected and the applicant for a 14-yr. design patent therefore had to risk twice as large a fee as one for a 17-yr. structural or process patent.

Realizing the unfairness of this situation, the new Commissioner of Patents has now decided that an applicant for a design patent who has paid the minimum fee of \$10 corresponding to a 3½-yr. term of patent may change his application at any time before the formal allowance thereof by paying the additional \$20, so as to have the patent issue for the 14-yr. term.

In view of the continually increasing number of cases in which appliances are designed with quite distinctive ornamental shapes or features, this new interpretation of the statute should lead to a more frequent use of a form of protection which has heretofore been restricted because of the heavy risk involved by the high initial fee.

How to Build Small Fireproof Garages of Reinforced Concrete

To keep the automobile safely and in the most efficient order and to preserve its appearance, there should be provided a permanent, fireproof garage. Concrete is the most suitable material for this purpose. A concrete building is warm in winter and cool in summer—very important considerations for the motorist who likes to “tinker” on his machine—and its fireproof qualities are self-evident and of the utmost importance where gasoline is so freely used.

The garage should not be planned of too small dimensions. It is desirable to provide space for a work bench fitted with a good machinist's vise and rack for tools, and allowance made for room to store oil, gasoline, extra tires and other supplies. For a single car a size of 18' long by 14' wide by 9' high (inside measurements) will be ample.

METHOD OF CONSTRUCTION

The foundations should be 12" wide by 3' deep and should extend 5" above ground level to provide for a concrete floor of this thickness. The concrete for the foundation should be a 1:2½:5 mix, using Portland cement, sand and screened gravel or crushed rock. Upon the foundations the 6-in. wall will be placed. Make the walls of 1:2:4 concrete. The walls are reinforced with ¾-in. round steel rods, spaced 14" o. c., and running both horizontally and vertically. The forms for the walls

can be built the full height, or movable forms of a height of about 3' can be used. Forms are made of 1-in. siding, well supported by 2-in. x 4-in. lumber to prevent bulging when concrete is placed. The movable forms are filled and raised each day until the entire 9' is completed. In order that the car may be easily run in and out of the garage, it is well to leave the entire entrance side open and fitted with large swinging doors. In the sides of the doorway embed bolts with heads in the concrete. These bolts will be used later for fastening the wooden door jamb which carries the hinges for the doors. Provide a good sized window in each of the three walls so that there will be plenty of light on the car when it is to be repaired or washed.

The concrete floor will be 5" thick, made of 1:2½:5 concrete, and will rest directly on the ground. The ground should be scraped and well rolled or tamped to secure a good foundation for the floor, which is laid after the walls are finished. Where

the car will stand the floor should be sloped to a drain at the center to carry off the water used in washing. If running water is obtainable the pipes should be laid before the foundation and floor are started. It is a good plan to provide for an underground gasoline storage tank with a pump extending up through the concrete floor.

The roof can be made either peaked or flat. The flat form is much easier for the average person to build. Such a roof should be constructed with a slope of about 4" toward the back of the building to drain off water. Make the roof 6" thick, of 1:2:4 concrete, and reinforced with ¾-in. round steel rods



FIG. 1—A SIMPLE CONCRETE GARAGE

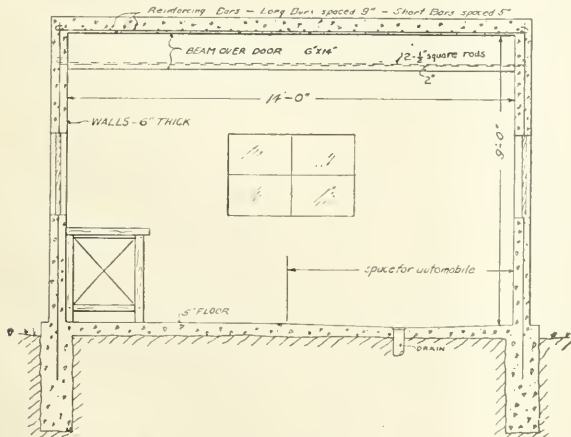


FIG. 2—SECTION OF A MONOLITHIC CONCRETE GARAGE

spaced 5" o. c. for the short lengths and 9" o. c. for the long lengths. These rods are located 1" from the bottom of the roof. Where the rods cross, wire them together to prevent shifting when the concrete is placed. Over the doorway, where there is no wall to support the roof, the weight is carried by a concrete beam 6" wide x 14" deep including the thickness of the roof. Both beam and roof are built at the same time. Two in. from the bottom of the beam place two ½-in. square twisted steel rods. The form for the roof consists of a flat platform of 1-in. boards on joists supported by upright studding. Be sure that the forms are strongly made and well supported so as to hold safely the weight of the wet concrete. This form should remain in place for a week or two after placing the concrete.

Make provision through the roof for a concrete chimney or sheet iron smoke pipe for a small coal or gas stove. The garage should be heated in winter to prevent freezing of the water in the cylinders and the radiator of the car.

Covers of Concrete for Wells Keep Impurities Out of Water—How to Build Them¹

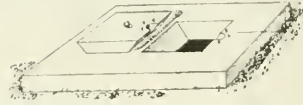
Even with an abundance of fresh air and wholesome food, the health of a country family is largely dependent on the purity of its drinking water. Since the principal source of farm water supply is the bored or dug well, the purity of the water is determined almost entirely by the ability of the well curbing and cover to keep out contaminating surface water. If the well is curbed near the top with solid concrete (or with blocks or bricks laid in Portland cement mortar) and is covered with a concrete platform, the healthfulness of the water is practically assured.

HOW TO MAKE THE REINFORCED PLATFORM

There are several methods of building a concrete well platform. The choice is dependent on the manner in which the pump barrel and the stock are joined together. In the illustration is shown a platform 5" thick and 5' square, which contains a manhole fitted with a concrete lid. The pump stock passes through the platform by means of a circular hole at the side and a part of the manhole opening. By this means the pump stock and the barrel can be joined together and slipped into position by a man working through the manhole. Afterwards the concrete manhole lid is set in place. Moreover this lid is heavy enough so that it cannot be removed by a child.

In preparing the well for a concrete platform, see that 4' or 5' of the curbing near the top of the well is of solid concrete (proportioned 1:2:1), or of blocks or bricks laid up with cement mortar mixed in the proportion of 1 part cement to 1½ parts sand. Carry the curbing 6" or 8" above natural ground level and grade the turf to this height so that surface water will flow away from the well. Prepare to mold the cover on a wooden platform of 2-in. boards laid over the well or placed on a level spot of ground. For most wells, a platform 5' x 5' x 4" thick is sufficiently strong. To provide for a manhole opening, build a bottomless box, 5" deep, 2' x 2' at the top and 18" x 18" at the bottom—outside measurements—using boards 1" x 6". Another plan is to have a tin-

smith make a round bottomless tin form 5" deep, 2' in diameter at the top and 18" at the bottom, after the pattern of a large, bottomless dishpan. To either manhole form attach a wooden block of the size and shape of the pump barrel or stock. Grease



CONCRETE WELL PLATFORM WITH MANHOLE COVER REMOVED

Bolt projections indicate where pump is fastened

the manhole frame and set it on the wooden platform where the opening in the well cover is desired.

Proportion the concrete 1 bag of Portland cement to 2 cu. ft. of sand and 4 cu. ft. of crushed rock, or 1 bag of cement to 4 cu. ft. of pit gravel. Have the concrete just wet enough to flush a little cement mortar when tamped into place. Over the entire wooden platform, except within the manhole frame, spread 1" of concrete. For reinforcing, immediately place on this concrete 5-ft. lengths of ¾-in. iron rods running in both directions (criss-cross) and spaced 9" apart. Bend the ends to a hook-shape. Strengthen the platform around the manhole opening by placing an additional rod on each side. Bring the cover to its full thickness at once by tamping in the remaining 4" of concrete. There will be needed three bags of cement, ½ cu. yd. of sand, ⅔ cu. yd. of rock and six pieces of ¾-in. by 10-ft. rods, weighing 23 lbs.

For fixing the base of an iron pump securely to the finished well platform, place in the soft concrete around the pump opening ordinary bolts (washer and heads down) to the depth of 4". To locate these bolts correctly, set them by means of a wooden block or templet in which holes have been bored and spaced exactly like those in the pump base. Lag bolts or similar devices may also be used for this purpose. Finish the surface of the platform with a wooden float and steel trowel the same as for sidewalks. If the greased tin form is used, the manhole cover may

be cast at the same time as the rest of the floor. Reinforce the lid with short lengths of iron rods laid criss-cross. As a lifting ring use half of an old bridle bit, or a hitching-post ring, the end of which is provided with a knob of twisted wire or with a nut and large washer. If the wooden manhole form is used, carefully remove it after four hours. One day later build the manhole lid the same as for the tin form with this exception—place greased paper or cardboard around the edges of the opening to prevent the new concrete from sticking to that of the platform. To make the manhole lid lighter in weight, before placing the concrete spread 1½" of wet sand over the wooden platform inside the manhole opening and then tamp in the concrete. Take care to place the reinforcing within 1" of the bottom of the manhole lid.

After the well platform is two weeks old, carefully remove the wooden boards on which it was built and set or lower it into place. Give the platform a slope of ½" in the desired direction by placing a layer of cement-sand mortar between the well curbing and the platform.

OTHER PLANS FOR MAKING THE PLATFORM

Some men prefer to make concrete well platforms in two pieces with the division line through the center of the pump opening. By this means the pump barrel and the stock are easily joined and inspection is readily provided for. In other cases where the pump and the stock can be joined together and lowered into the well as one piece, the concrete platform (removable) is made as a unit and with a single opening merely large enough to receive the pump stock.

Concrete well platforms built according to these methods can be depended on to protect the well from mice, vermin and scrub-water.

Over 2,000,000 concrete block have been used so far in the new \$10,000,000 plant of the Minnesota Steel Co., at New Duluth, Minn. The company is now about to start the construction of 200 concrete block houses and 65 apartment buildings, each to accommodate six families. The plans which have been prepared by Dean & Dean, architects, Chicago, call for block walls and monolithic floors. Considerably over 100,000 bbls. of Universal Portland cement has been used in the new buildings of the Minnesota Steel Co.

¹Description supplied by Am. Assn. Portland Cement Mfrs.

The Relation of Strength to the Temperature in Green Concrete

BY WARREN A. HOYT¹

In making further comments upon the Stark-Lyman building failure at Cedar Rapids, Ia., I call your attention to an article published by the *Engineering Record* (Jan. 18, 1913) under title, "Influence of Temperature on Concrete."

In this article it is stated that "it is not uncommon in building construction to get an arrangement of form supports for new floors which, during the pouring of the concrete for the floor above, will impose a load on the supporting floor considerably greater than the full load for which it was designed. If the supporting floor is but seven das. or eight das. old, it is able to carry little or no external load and the weight of the green floor must be transferred to the second floor below. If this second floor is but 15 das. or 16 das. old, it probably can carry but little external load, etc."

This condition is or should be common knowledge with "experienced" builders. Yet, what have we in this Cedar Rapids failure under the supervision of an "experienced" superintendent? While the exact causes of this failure have not yet been recorded, certain conclusions can easily be drawn. The structure was designed for light live loads with high unit stresses for the materials. Erection took place during cool (not cold) weather with no attempt to heat materials. Loads on form supports or posts were not well distributed.

The fifth floor, the last from which forms were removed, was placed 32 das. before the failure. In these 32 das. there were 21 nights that the thermometer recorded 32° F. and below, and the average of the mean daily temperature for the period was 39° F. The sixth floor had been completed 22 das. before failure with still lower average temperature. The seventh floor was poured 13 das. before the failure and the roof was being poured at the time of the collapse.

According to the diagram of strength and suggested method of

determining, roughly, the strength of concrete in cool weather, outlined in the *Engineering Record* article mentioned above, the fifth floor concrete would have reached a compressive strength of nearly 1,200 lbs. per sq. in. The sixth floor would have developed a strength of about 1,000 lbs. per sq. in., and the seventh floor about 950 lbs. per sq. in.

The dead load of the floor slab was about 67 lbs. per sq. ft., and that of the roof slab, about 62 lbs. which, with workmen, wheelbarrows of material and saturated forms could easily be increased to 95 lbs. per sq. ft. over a small area. A little over one-half of a roof panel was poured when the collapse occurred. Form posts were spaced 4' o. c. each way; thus a single post would receive from the roof 1,520 lbs. or more. Of the four posts parallel with the ribs, and supported by one rib on the floor below, two would be fully loaded and two partly loaded (as the roof was only partly poured) giving at least 3,800 lbs. on a single rib. (It will be recalled that the floor construction was combination tile and concrete ribs, and that small blocks only were used under posts). The seventh floor is hardly able to support its own dead weight and the sixth floor, we will assume, able to support itself. The saturated forms and rubbish for these two floors will add, say 18 lbs. per sq. ft. each. Thus as a minimum condition we get an accumulation of loads to be supported on the fifth floor of 3,800 lbs. from roof plus 2,300 lbs. from forms and say one-fourth of seventh floor or 1,070 lbs., making a total external load of 7,170 lbs. or 2.8 times the load for which the floor was designed, this supporting floor itself having reached only a little over one-half of its full strength. It is not strange that it failed. The strange thing is that such a condition was permitted to exist.

HEAT AN ESSENTIAL IN CONCRETE

It should be repeated again and again that the elements of concrete are cement, stone, sand, water and HEAT, all correctly proportioned and thoroughly mixed. That nature often gratuitously supplies the heat

is no reason for omitting it when she withdraws her benefaction.

If materials had been heated in this case, as an experienced contractor would have done, if only as a consideration of economy, then the chances are there would have been no failure, despite other omissions.

The point I wish to raise again, and its importance this disastrous failure distinctly emphasises, is the necessity of more knowledge of the action of concrete under cool weather conditions. There is sufficient present knowledge to have avoided such a disastrous failure as the one mentioned, yet there is great need of more reliable information as to the effect of low temperature upon the setting action of concrete. At present if the thermometer lurks around 40° or 45° while concreting is in progress, we have to guess at its strength at different periods of elapsed time. No amount of "experience" is adequate here for all conditions, unless this experience is fortified by experimental knowledge.

There was a man of unusual experience in charge of this unfortunate building and yet there occurred the most disastrous failure in concrete building construction. Much of his experience, however, had been with heavy, massive work where a "mis-guess" is not so serious.

Some of our material testing laboratories should take this matter up and execute a series of experiments wherein the temperature element can be controlled and made the variable element, all other features being made constant. This would require a large number of tests to make the results general and reliable for use under the varying conditions of construction.

In illustrating the use of the table for strength, given in the article above mentioned, let us take the sixth floor concrete of this building which was 22 das. old at time of failure. Concreting was completed Oct. 23. The mean temperature for the 23rd was 41° F., following three days whose mean temperature was near 32° F. or less, consequently all materials would be thoroughly chilled; thus we could take from the table the number representing the first day's developed strength, somewhat less than the number opposite 41° as mean daily temperature (m. d. t.), say 37 lbs. For the second day the mean daily temperature was 48° and corresponding to this the increment is 100 lbs. 3rd da. m. d. t. is 30½°, increment is 95 "

¹Consulting Engineer, Chicago

DAILY INCREMENT OF STRENGTH IN LBS. PER SQ. IN. OF 1:2:4 GRAVEL CONCRETE

Mean Daily Temp. (Fahr.)	Age of Concrete in Das.														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	12	12	10	7	5	4	3	3	2	2	2	2	2	2	1
36	25	25	20	15	10	8	7	6	5	4	3	3	3	2	2
38	37	37	30	22	15	12	10	9	7	6	4	4	4	3	3
40	50	50	40	30	20	16	11	12	10	8	6	6	6	4	4
42	62	62	50	37	25	20	17	15	12	10	7	7	7	5	5
44	75	75	60	45	30	24	21	18	15	12	9	9	9	6	15
46	87	87	70	52	35	28	24	21	17	14	10	10	10	7	and
48	100	100	80	60	40	32	28	21	20	16	12	12	12	8	above
50	112	112	90	67	45	36	31	27	22	18	13	13	13	9	same
52	125	125	100	75	50	40	35	30	25	20	15	15	15	10	as
54	137	137	110	82	55	44	38	33	27	22	16	16	16	11	14
56	150	150	120	90	60	48	42	36	30	24	18	18	18	12	
58	162	162	130	97	65	52	45	39	32	26	19	19	19	13	
60	175	175	140	105	70	56	49	42	35	28	21	21	21	14	
62	187	187	150	112	75	60	52	45	38	30	22	22	22	15	
64	200	200	160	120	80	64	55	48	40	32	24	24	24	16	
66	212	212	170	127	85	68	60	51	42	34	25	25	25	17	
68	225	225	180	135	90	72	63	54	45	36	27	27	27	18	
70	237	237	190	142	95	76	67	57	47	38	28	28	28	19	
72	250	250	200	150	100	80	70	60	50	40	30	30	30	20	

Formula for above values for 7 das.; S_7 =strength at 7 das., t_1, t_2 , etc.=mean daily temperatures for 1st, 2nd, 3rd das., etc.:

$$S_7 = \frac{1}{4} (25t_1 + 25t_2 + 20t_3 + 15t_4 + 10t_5 + 8t_6 + 7t_7).$$

For 14 das.:

$$S_{14} = S_7 + \frac{1}{4} (6t_8 + 5t_9 + 4t_{10} + 3t_{11} + 3t_{12} + 3t_{13} + 2t_{14}) + 8/10 (1100 - S_7).$$

For 10 das.:

$$S_{10} = S_7 + \frac{1}{4} (6t_8 + 5t_9 + 4t_{10}) + 3 \times 8/70 (1100 - S_7).$$

4th da. m. d. t. is 34°, increment is	7	"
5th da. m. d. t. is 34½°, increment is	7	"
6th da. m. d. t. is 37°, increment is	10	"
7th da. m. d. t. is 32°, increment is	0	"

Total for first 7 das. 256 lbs.

8th and 9th das. m. d. t. is 27½° and 31°, increment is	0	lbs.
10th da. m. d. t. is 36°, increment is	4	"
11th da. m. d. t. is 48°, increment is	12	"
12th da. m. d. t. is 41°, increment is	9	"
13th da. m. d. t. is 38°, increment is	4	"
14th da. m. d. t. is 44°, increment is	6	"
15th da. m. d. t. is 53°, increment is	10	"
16th da. m. d. t. is 45°, increment is	7	"
17th, 18th, 19th, 20th das. m. d. t. is 32° and below, increment is	0	"
21st da. m. d. t. is 46°, increment is	7	"
22nd da. m. d. t. is 37°, increment is	3	"

Total 318 lbs.

The undeveloped strength brought over and made available from first 7-da. interval=(1,100—256) .8 = ... 675 "

Total 993 lbs.

As crude as this method is, it is better that a mere guess, even by an experienced man.

If maximum and minimum ther-

held in position with a concrete stud poured in place.

This wall, which can be made in any thickness from 5" upwards, is formed of slabs 36" x 12" x 2" cast with a dovetail vertical joint. When the slabs are being built, as in the manner of ordinary partition slab work, a reinforced concrete post is built up at the same time between the two walls 36" o. c.

The forming of the post simultaneously fills the vertical dovetail joint in the slab, which thereby becomes part of the post and rigidly ties the two slab walls together. The steel of the posts is anchored into the foundation and is carried into the beam on top, thereby giving the same value as *in situ* panel construction, without the disadvantages due to contraction.

The system also permits engineers and architects to provide a finished face for their work, without the cost of the hacking and plastering.

The wall is considered very good for agricultural cottages, etc., as the slabs, being made of a wet concrete, and therefore of greater density, do not have the same tendency to absorb moisture as a concrete block made on the dry system. Experience has shown that a section of this wall, erected with slabs cast wet, constitutes an impermeable construction, even with a slab thickness of only 2". The wall can be made up to a width of 13½" at practically no additional cost either in material or in construction. The slabs shown in this illustration were cast wet and compacted on an oscillating machine by the "Jagger" process.

*Controlled in England by the Improved Construction Co., London, and in the U. S. by the Nat. Cement Products Co. of Delaware, Philadelphia



A WALL USING PRE-CAST SLABS AND POURED IN PLACE STUDS

Four Causes for Defects in Concrete Paving—All of Them Avoidable¹

BY FRANK F. ROGERS²

Concrete can no longer be regarded as in the experimental stage as a surfacing material for county roads and on certain streets for city and village pavements. It has long been accepted as the most suitable material for the foundation of pavements for city streets, no matter what material is used for the wearing surface. There has been a great deal of discussion, however, as to its suitability for a paving material when used for both the foundation and wearing surface.

Unfortunately most of what has been written both for and against concrete for road surfaces has come from persons directly or indirectly interested in the sale of cement, or on the contrary, interested in the promotion or sale of some other materials for surfacing both city pavements and country roads. Under such circumstances, no matter how honest the writer may attempt to be, his arguments and conclusions almost invariably coincide with his interests. We have Scripture for it, that "where the treasure is there will the heart be also."

The last five years have seen an immense yardage of concrete pavements laid in the cities and small towns of the country and a rather large mileage of concrete laid on country highways. Michigan, Wisconsin, Illinois and Iowa are the states which seem to have been most active in this work.

The writer has observed pavements built of this material in many cities, and has seen all the concrete roadways that have been built in Michigan, possibly 75 miles in all. A paper giving the results of a rather minute study of some thirty miles of the concrete roadways in Wayne county, Mich., was prepared by him for the American Road Congress recently held at Detroit, but as this paper has been published in full in most of the engineering journals no further reference will be made to it at this time. As to the pavements, it must be said that a few of them are without defects, but most of

these can be traced to the following causes:

- (a) Too lean a mix.
- (b) A poor aggregate.
- (c) Poor foundation, including inadequate drainage.
- (d) Lack of suitable expansion joints properly spaced. And it should be added that about all of the observed defects in concrete roadways can be traced to one or more of the above causes.

LOOK OUT FOR LEAN MIX

A large percentage of the defects in city and small town concrete pavements may be charged to a lean mix, especially where two-course concrete has been laid. There has been much talk about satisfactory pavements of this kind at a cost of from 75 cts. to 80 cts. per sq. yd. Any attempt to build concrete pavements or roadways at these prices is a sure bid for failure. Under favorable conditions and with careful workmanship the writer believes that the two-course pavement can be made a success. If so the top layer must be put on before the bottom layer has had time to take the initial set, and the mix should not be leaner than 1:2½:3 for the base, nor than 1:2:3 for the top. I would prefer a one-course concrete with a 1:2:3½ mix, taking great care in the selection of the aggregate both as to hardness and toughness of the crushed rock or pebbles, and in the proper grading of both the coarse and the fine aggregate so that the utmost possible density would be secured.

Experience thus far has convinced the writer that it is much easier to secure a satisfactory cement than to secure a suitable aggregate. Results in Wayne county seem to favor washed pebbles and sand rather than crushed cobbles for aggregate. This is rather hard to account for when one considers that the pebbles represent about the same variety and character of rocks that we get in our cobbles. It is quite possible that a better gradation from fine to coarse is secured with the pebbles, thus making a denser material. No matter what the theory, there can be no question that the pebble concrete makes the most durable surface and

one which wears more evenly than others.

In the accelerated tests on two sections of concrete and two sections of brick made at Detroit during the recent Road Congress, the concrete in which Wisconsin granite, a rock as hard and tough as most traps, was used for the coarse aggregate, wore much better than the section where washed pebbles were used. It should be stated, however, that the price of Wisconsin granite delivered in Michigan is too high to allow it to be extensively used as an aggregate either for concrete pavements or roadways. The only materials that are commercially available at prices that can be considered are washed pebbles, crushed cobbles and limestone. So far the latter has been used but little for road purposes, but I am of the opinion that the best grades of lime rock are worth considering in this connection, especially on the secondary roads. The limestone (which is a dolomite) would at least wear evenly which is not true of the cobbles owing to the varying degrees of hardness and toughness in the different varieties of rocks found among the cobbles in our state.

WATCH THE FOUNDATION

To avoid cracks the foundation must be absolutely stable and free from water at all seasons of the year. Where old traveled highways can be used for the foundation with only enough changes of surface to make a smooth sub-grade, the conditions are ideal. Where such conditions are found in Wayne county long stretches of roadway 15' and 16' wide may be seen, perfectly free from longitudinal cracks. On the other hand any cut or fill more than 1' or 2' in depth is almost sure to produce longitudinal cracks in the concrete, unless it is very narrow.

Experience has proved that from 25' to 33' is a suitable spacing for transverse joints. By way of experiment a 150-ft. stretch of 16-ft roadway was laid on Michigan Ave., Wayne county, this year without expansion joints of any kind. Before the road was opened to traffic nature had supplied the transverse joints spaced from 18' to 26' with one extra thrown in for good measure.

Any kind of crack except the expansion joints in a concrete roadway is some reflection on the design, workmanship, or material. There is no doubt that if all the knowledge we now have on this subject were utilized in design and construction, pavements and roadways of this material could be laid that would remain almost free from the defects

¹Paper presented at the 10th. annual convention of the American Road Builders' Assn., Philadelphia, Dec. 9-12, 1915.
² State highway commissioner of Michigan

named. There is some question, however, if to do so would not make the expense of the pavement or roadway so high as to be practically prohibitive. So far the tracks that have been found are not more difficult to handle than the expansion joints and apparently are not much more objectionable except for their unsightly appearance when repaired. However, if they should eventually become too numerous they would necessarily cause the destruction of the pavement or roadway.

Concrete Road Harder to Break Than Anticipated

A letter from J. Kerwin, Supt. of Tracks, Detroit, Jackson & Chicago Ry., to the Board of County Road Commissioners, Wayne County, Mich., carries an unusual testimonial to Wayne county concrete. The letter is published together with two of the views mentioned by Mr. Kerwin:

When we undertook to build our track across your concrete road east of the village of Wayne some weeks ago we encountered a more difficult job than we had figured on. We intended to put this track across the road in as short a time as possible and put a gang of about 20 men at work to break through the concrete road. We expected they would have the concrete removed in about three hrs. It took them, however, about 15 hrs. In order to break the concrete it was necessary to raise it with jacks and break it off in large slabs, which then had to be broken into smaller pieces to be moved off the highway. It was the hardest concrete that we have ever had to break through.

I thought it worth while to photograph some of the large slabs of concrete after we had removed them. I am sending you herewith a set of five photographs showing the broken concrete.

CONCRETE-CEMENT AGE will have an office at the Chicago Cement Show. We hope to meet you there.



Make Experiments in Waterproof Concrete

A series of tests to determine the rate and the amount of flow of water through concrete is being made by the College of Engineering of the Univ. of Wisconsin, Madison, Wis., with the object of finding a simpler means of making concrete watertight. Some interesting results have already been secured in the effect of the length of the time of mixing in a machine mixer of the batch type; the effect of the percentage of water upon the imperviousness of the concrete; the effect of having sand in dry condition before mixing; and the effect of having the sand wet.

It has been found that good results are obtained if the concrete remains in the mixer from two min. to three min. when dry materials are employed. For cases in which the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments show that 1:1½:3 mixtures consisting of cement, Janesville sand of the torpedo grade, and Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 lbs. per sq. in. Mixtures as lean as 1:6, using a graded gravel, have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch.

The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are 13½" in diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4" to 18". Ample provision is made for cleaning both

faces of the cylinder before placing it upon the testing apparatus. The apparatus itself is so arranged that very accurate tests can be made.

The importance of these experiments will be more sufficiently appreciated when it is understood that a large proportion of the trouble arising from poor concrete is due to the use of defective sand or gravel.

Change of Size in Concrete Columns

The question of change of size of columns in the successive stories of a building is one of cost. The expense of changing the forms is usually greater than the cost of the concrete saved on small columns where the reduction is less than 3 in. and on large columns where the reduction is less than 2 in., according to a paper read by Leonard C. Wason, pres., the Aberthaw Construction Co., Boston, before the Boston Soc. of Civ. Engrs.

It is often not economical to change the size every story. Frequently when the column would otherwise be reduced, it is desirable to use the size of the lowest story columns in order to avoid the expense of splicing at the sides and the bottoms of forms for beams and girders. Sometimes when the upper floor has a lighter load to carry than the lower, it would be possible to reduce the size of beams. Economy in form work dictates that the depths may be reduced but not the widths, because this would require splicing out all the floor panels and joists, which is more expensive than the saving in concrete in the beams amounts to.

Members of the International Bricklayers' and Stonemasons' Union of America declare that many hundreds of thousands of dollars will be spent by the union to promote brick construction instead of concrete masonry where either type would answer the purpose. A large fund is said to have been set aside for this use. Part of the plan of the campaign proposed is to help finance clay product manufacturing plants wherever there is a strong tendency toward the use of concrete instead. It is proposed to erect the first plant of this kind at El Paso, Tex. It is stated that \$250,000 has already been voted by the international union for this purpose.



BREAKING UP WAYNE COUNTY CONCRETE TO LAY TRACKS

Notes on Sidewalks and Pavements of Concrete in Grenoble, France

The information here presented as to concrete sidewalks and pavements in the city of Grenoble, France, comes to us through the courtesy of M. de Pulligny, Director of the French Mission of Engineers in the United States. In forwarding the manuscript in French, which we have here translated, M. de Pulligny remarks that especial interest attaches to the concrete work of this kind in Grenoble because it is at this place where the French engineer Vicat originated his celebrated experiments on cements, which were followed by a wide-spread use of the material. Cement manufacturing is an active business at Grenoble and its citizens

naturally favor its use in their city paving, and it is not unlikely that the municipal engineers in that section have a longer experience in its use in paving than anywhere else. The information was gathered for CONCRETE-CEMENT AGE through M. Le Gavrian, Engineer of Bridges and Roads, Versailles, and it consists in a summary of the city specifications of Grenoble for building cement-concrete sidewalks and roadways, with comments on the work made by municipal engineers at Grenoble. The requirement of a ten year guarantee of the work will be of special interest to contractors in the United States.

The pavements shall be constructed exclusively with artificial cement accepted by the municipal administration. They shall be built in the following manner:

Sidewalks—1. A layer of screened gravel .35m. (1.15 ft.) thick, well tamped.

2. A layer of cement concrete .12m. (.39 ft.) thick, composed of not more than 6 parts of gravel to 1 part of cement.

3. A top dressing .03m. (.098 ft.) thick, composed of 1 part of washed, screened Drac gravel or other similar aggregate and 1 part of the same cement.

4. A layer of tamped sand spread two or three hours after completion of the top dressing and left in place until the latter has completely set.

Roads—1. A layer of screened gravel .35m. (1.15 ft.) thick and having a maximum diameter of .06m. (.019 ft.) well tamped.

2. A layer of cement concrete .20m. (.656 ft.) thick mixed in the proportion of 6 parts of gravel and 1 part of cement.

3. A top dressing .05m. (.016 ft.) thick composed of 1 part of washed screened Drac gravel or other similar aggregate and 1 part of the cement.

4. A layer of sand .05m. (.016 ft.) thick spread two or three hours after the completion of the top dressing.

5. A protective covering in jointed panels at least .025m. (.082 ft.) thick, attached to cross pieces placed 5 or 6 hours after the completion of the top dressing.

any holes. The excess shall be removed by means of a movable iron-shod template resting on the upper edges of the cross pieces.

TO BE TROWELED RAPIDLY

The surface of the top dressing shall be worked with trowels with sufficient rapidity so that the operation may be completed before the mortar has begun to set and harden. It shall immediately afterwards be sprinkled.

Sidewalks shall be immediately jointed following the established design.

The joints shall be either smooth or made with a jointing tool of the type specified by the chief of the service.

In pavements without expansion joints, the top dressing of a completed panel next to one which is about to be made, shall have its edges roughened for a distance of about 1 cm. and the joints shall be chiseled in such a way as to furnish a fresh surface to insure proper union between successive panels.

In pavements with expansion joints, the joints shall be made in the top dressing and at about 1 cm. (.032 ft.) from the edge of the panel adjoining the panel under construction, and all of the part next to the joint shall be roughened with a chisel as is provided above for pavements without expansion joints.

After the top dressing has set, a layer of sand shall be spread on the pavement and it shall then be opened to foot traffic.

The protective covering shall be placed 5 or 6 hours after the completion of the top dressing and shall itself be covered with a layer of sand. As soon as these two operations are completed, the pavements shall be opened to vehicular traffic.

CAREFUL CURING

The contractor must maintain the layer of sand on sidewalks during a sufficient length of time for the pavement to resist traffic. This time cannot be longer than two weeks.

The contractor must also maintain the layers of sand and the protective covering of pavements during the length of time necessary for the pavements to bear vehicular traffic. The length of time cannot be greater than two months.

The sand must be kept constantly wet.

The contract price includes all of the previous work, equipment, frequent watering, taking up the sand spread on the surface, the cost of

The top dressing must always have sufficient thickness so that the workmen will not be obliged to fill

the protective covering and that of the precautions necessary to protect the pavement from rain, sun and dust.

The price also includes plastering foundations and joints with cement mortar, as well as the edges of sidewalks in preparation as the work progresses.

The contractor will be responsible for his work not only while his contract is in progress, but for a period of ten years, during which time he must maintain the pavement entirely at his own expense and keep it in a perfect state for traffic at every point of the paved surface. He shall be especially responsible for, and he must repair at his own expense, damage to the pavement, sidewalks and roads caused by trenches, settlement or any other cause. If he does not comply with the orders of the Department relative to repairs of damage, except from abnormal wear and tear, the administration shall make the repairs itself at the expense of the contractor, who shall be obliged to pay the bill presented by the Department even in the case of repair to the entire pavement, if the state of the latter before the expiration of 10 years requires such repairs.

A TENTH OF CONTRACT PRICE WITHHELD

Work shall be paid for nine-tenths immediately after the pavement is utilized for traffic and the last one-tenth shall not be paid until ten years after the first payment. Repairs shall always be within the limits of the lines of the old joints. They shall, therefore, always follow a perfectly straight line.

The contractor must, in the case of repairs, as in new work, cover all pavements with sand or with a properly arranged protective covering upon the surface and take every precaution to keep the pavement in good condition for traffic.

The Municipal Department reserves the right to cause test sections of pavement to be laid at points designated by it and without any cost to it by cement mills whose products are made in the district.

No test pavement so laid shall be greater in extent than 100 sq. m. for each competing mill. These pavements shall be completed according to the foregoing specifications. The total of these test pavements shall not be more than 10% of the total pavement built by the contractor while his contract is in force.

For pavements leading to gateways, etc., the same specifications

must be observed in respect to the care taken in doing the work and the contractor must conform in the matter of thickness, of dry stone, lean concrete and top dressing with the specifications which are given him by the administration.

COMMENTS ON WORK

Sidewalks are not subject to any up-keep, but generally at the end of 30 to 40 years cracks appear as the result of settling of the soil or the result of use, and their repair is necessary.

Roads, when they are well constructed, do not require any up-keep for 8, 10 or 15 years according to the heaviness of the traffic, but as the material is not perfectly homogeneous, the wear is very irregular. Holes form and become deep and have to be filled up. In order to do this, the sides of the holes are chipped out down to the concrete of the foundation. The top dressing is then applied and protected in the same manner as a new pavement. From the time that these repairs begin, the cement concrete pavements cease to be desirable for they must be patched every year, they lose their uniformity, water collects in the holes and they are constantly covered with patches. Finally, when the top dressing is too much cut up by use and repairs, the entire construction must be gone over again.

Pavements in cement concrete present almost exactly the same advantages and the same inconveniences as do those of asphalt. They are a little less slippery, a little more noisy, their up-keep is less easy and more troublesome because concrete has to be protected for 1 or 2 months, according to the season; while asphalt pavements are open to traffic as soon as the material has cooled. The protection of concrete fills the roads with obstacles and produces mud and dust. The reconstruction of a cement concrete road requires that the foundation and the top dressing shall be taken out while with an asphalt road it is necessary to remove and replace the top dressing only.

Roads paved with concrete must be prohibited in streets through which tramways run because of the lack of continuity on either side of the rails, which constitutes a weak point in the pavement. Conduits for water pipes, gas pipes, electric wires, sewers, etc., also form breaks in continuity unfavorable to the continued existence of the pavement.

Rock Mixtures For Portland Cement

In a recent article in one of the engineering papers on "Natural Asphalt Deposits of California" the statement is made that this asphaltic rock which is composed of layers of saturated sand or of practically bituminous sandstone, contains all the ingredients necessary for a good pavement but not in the correct proportions thoroughly and homogeneously mixed. To prepare the material, therefore, for actual use, it is necessary to disintegrate it by the application of heat and thoroughly to remix it before it is in a commercial state.

The interesting fact in connection with this treatment of the natural asphalt is that in many ways it is similar to the practice of handling the natural Portland cement rocks of the Lehigh district, where practically a similar condition prevails.

Many of these rocks contain all the chemical ingredients for Portland cement in the proper proportions, but, unfortunately, these ingredients are not definitely distributed in relation to each other through the entire rock, and therefore in order to use the rocks, for cement, it is necessary to pulverize them and to calcine this powder in rotary kilns, thus producing a new uniform rock with all the ingredients in proper uniform proportion to each other so that when the new rock mixture thus produced is burnt and is ground to impalpable powder the product may be the uniform well-known Portland cement of commerce.

Development in Cement Testing

As a sign of the times newspaper reports from various smaller cities in the country are of interest in describing the adoption of cement testing apparatus in various city Engineers' offices. Needless to say, in the general growth of the use of cement for municipal work of every character, roads, sewers, bridges and buildings, the concurrent development of cement testing is an essential fact. It is a sign of the times to find from the press of all over the country this general introduction of the testing laboratory in municipal engineering offices, and it is a wise and proper thing on the part of city engineers in every section of the country to take this progressive step in securing the proper control of the testing of the most important material of construction that now goes through their hands.

A Many-Sided Discussion of Best Practice in Concrete Road Construction

It is in discussion that the fine points of opinion and the experiences in the whys and wherefores on which the opinions are based, are brought out. For that reason a great deal of valuable information is contained in the matter here presented, being portions of discussions by members of the American Society Civil Engineers, as published in the Proceedings of the organization. Many of the moot questions of concrete paving are gone over and the opinions expressed, though divergent in some cases, should be valuable.

DISCUSSION BY J. A. JOHNSTON²

Great care is requisite in order to obtain good results in concrete pavements. In discussing the value of such pavements, there is, of course, some question as to the kind and amount of traffic they will stand. In Massachusetts, in 1906, a concrete surface was laid on a section of State highway in the town of Spencer, and stood the traffic remarkably well. The principal objection was that it was rather hard for the feet of the country bred horses, which, if allowed to select the traveled way, turn out on the earth shoulders. A bituminous surface remedied this condition, and at present the road is giving excellent service. The section mentioned was put down by the grouting method, known as the Hassam process. On investigation it was found that the grout had penetrated, not only 6 in. of broken stone, but an additional 2 in. of gravel sub-surface. Very little trouble was experienced from disintegration of the concrete surface; it was confined principally to the area adjacent to the expansion joints.

Since that time some roads have been built by mixing the concrete before placing. Care had to be taken to have the batch properly tempered, particularly in building on a grade. If too wet, the mortar had a tendency to creep and form waves on the surface, and, of course, a dry mix-

ture was not readily flushed, hence it was difficult to get a good smooth surface. The concrete was placed in a single layer, and as near a mosaic surface as possible was decided, in order to permit the bituminous material to bond properly. To obtain that result, various methods were tried. After placing the concrete, dry stone was spread over it, and tamped lightly. This worked well, but required considerable skill on the part of the men who were spreading the broken stone. The experiment of allowing the concrete to set 24 hours, and then brushing it off with a steel broom, gave, perhaps, the most satisfactory results.

MIXTURE TOO LEAN

There is a tendency to use too lean a mixture for concrete road surfaces. Many engineers have advocated a 1:3:6 mixture, but that is not rich enough, for concrete exposed to the traction of wheels and blows from horses' hoofs must be very tough to resist abrasion. Added strength cannot be gained by reducing the percentage of stone aggregate, that is, assuming 2 parts of sand to be the correct quantity to be used with 1 part of cement. Such a mortar will fill the voids in 4 parts of stone, and no added strength is gained by reducing the stone aggregate to three parts. Too small a proportion of stone means a large percentage of mortar, thus giving a smooth surface, which would be slippery and not desirable.

The concrete pavement has the advantage of being not only a surface, but also a foundation. Though, of course, there may be conditions where some treatment of the sub-surface will be needed, with a uniform soil, in which the frost action is about the same in all parts, there is very little difficulty. If, however, the soil is varied, so that the frost will affect one portion of the road more than another, the concrete will crack. It is an unusual condition where such cracks are serious enough to disintegrate the concrete, and any ordinary cracking is not material. This is particularly true where concrete is coated with a bituminous material, as the cracks are then sealed over and give no trouble. With concrete, as with all other smooth paving, the surface is rather slippery, necessitating care in de-

signing the maximum grades and the camber of the road.

APPLY TAR ON WET SURFACE

A light bituminous top on a cement-concrete base solves many road problems. It is reported that there is much difficulty in making the bituminous material stick to the concrete. In Massachusetts success has been obtained by the following method: The concrete surface is swept as clean as possible, then sprinkled with water, and while still wet covered with Tarvia A, heated to 200 Fahr. and applied at a pressure of not less than 70 lbs. per sq. in., and at the rate of $1\frac{1}{4}$ gal. per sq. yd. of surface. This is then covered with clean stone screenings (not exceeding $1\frac{1}{2}$ in. in diameter and from which the flour has been removed) spread at the rate of 0.015 tons per sq. yd. of surface. This is again watered and while still wet a second $1\frac{1}{4}$ -gal. coating of tar is applied in the same manner as before, but covered with clean, gravelly sand, using 0.015 cu. yd. per sq. yd. of surface.

The speaker is aware that the application of tar on a wet surface is contrary to existing theories, but it has worked satisfactorily. This road, treated in August, 1910, has cost to date, \$15 for total repairs on more than 1,000 lin. ft. of 15-ft. surface, and it has taken only 30 gal. of tar to replace such small places as have sealed off. The speaker believes that the successful adhesion of the tar to the concrete is due to the wet surface of the latter and the high pressure used in spraying the tar on the road.

DISCUSSION BY A. H. BLANCHARD³

Although cement-concrete pavements have been used in the United States since 1893, various details of construction and maintenance are as yet in an experimental stage. Many miles of cement-concrete pavements have been examined by the speaker, and the only ones which have been observed to be free from cracks are those which have been carefully constructed by the mixing method, and built on a well-drained, thoroughly compacted foundation, with adequate transverse expansion-contraction joints. Such joints are necessary, if successful results are to be expected, and both longitudinal joints along the curbs and transverse joints should be provided. If there are no expansion-contraction joints, the tensile strength of the concrete will probably be exceeded when the con-

¹From the Proceedings of the American Society of Civil Engineers, Vol. XXXIX, No. 7, September, 1913, page 1683. Road Construction and Maintenance. An informal discussion at meetings Jan. 17-18, 1913, only recently become available in the society's publication of the proceedings.

²Member Am. Soc. C. E.

³Prof. Hy. Engrg., Columbia University.

crete contracts, and the pavement therefore will crack; when it expands, it will tend to bulge, and if the expansion produces forces which are in excess of the compressive strength of the concrete, the latter will crush at the cracks. It is obvious that the edges of the joints should be protected from the abrasive action of traffic, and it is likewise apparent that the joints should be filled with a material which will provide for movement between the joints as the pavement expands and contracts.

The maintenance of cement-concrete pavements is difficult, as it is necessary to keep traffic off the freshly laid patches. It would seem advisable to use a bituminous concrete for patching, and the bituminous cement should be of such a character that the bituminous concrete will be stable after thorough compression by tamping or otherwise. Naturally a cement-concrete pavement repaired in this manner will not be pleasing from an aesthetic standpoint. However this point is not one of weight, as in all probability a large percentage of cement-concrete pavements constructed in the future will be finished with a bituminous surface.

DISCUSSION BY SANFORD E. THOMPSON⁴

One of the problems to be considered in the construction of concrete pavements is that of expansion and contraction due to changes in temperature. Contraction caused by the lowering of the temperature produces cracks, not only in concrete which is not reinforced, but also in brickwork or stonework. In the latter, however, the cracks are not apt to be so noticeable, because they follow the line of the joints.

Although it is possible to reinforce concrete pavements with steel so that the size of the cracks is inappreciable, the introduction of steel in sufficient quantity for this purpose is somewhat questionable from the standpoint of cost, and the problem, therefore, resolves itself generally into the location of the cracks where they are wanted, so that they will have smooth joints instead of rough, irregular lines.

AVOID LONGITUDINAL JOINTS

Longitudinal joints through the middle of the pavement should be avoided if possible. Sometimes it is advisable to make a longitudinal joint on each side of the pavement next to the curb. The spacing of

joints across the pavement depends on climatic conditions and the extremes of temperature that will occur in the given locality. A spacing of from 20 to 30 ft. is common practice in first-class construction. If the concrete is laid in cold weather, at a temperature not very much above freezing, its tendency to contract is less, and the cracks will be apt to occur at a greater distance apart. In some cases, this fact may be taken into account in locating the cross-joints.

It is possible to calculate quite closely the actual amount of contraction which will take place during a falling temperature, and to determine the approximate size of crack that is likely to open. The coefficient of expansion of concrete is approximately 0.0000055; that is, for every degree of fall in temperature, the concrete contracts in this ratio. Suppose, for example, a section of concrete is 50 ft. long and that it is free to expand and contract, the actual contraction caused by a fall in temperature of 40° Fahr., theoretically, would be $0.0000055 \times 40 \times 50 = 0.011$ ft., which is about $\frac{1}{8}$ in. In several cases the speaker has had occasion to check this theoretical contraction in actual concrete structures, and has found that it agrees closely enough for practical purposes. In one case, for example, he measured the contraction in a long, reinforced concrete, freight shed in which joints had been left at intervals; another case was in a large reservoir bottom, which was free to expand on one side; a record of the tests in the Croton Dam has been published.⁵

The necessity for frequent joints, in the first place, is to keep them small in size, and, in the second place, to prevent irregular cracks from opening up between them. There are certain patents on the market for steel-bound joints, which prevent chipping at the edges. It is a question, however, whether it is not more economical to place the joints at fairly close intervals, except where the road traffic is very heavy.

The question of expansion requires very little consideration. Many concrete pavements are built with open joints filled with a bituminous mixture to permit expansion. In ordinary cases, where the pavement is on a uniform grade, this is not necessary, because any expansion will be taken up by the concrete itself, usually by producing compressive stresses.

FAILURE DUE TO POOR AGGREGATE

Many failures of concrete pavements are due to the poor quality of the aggregates. Not only must the sand of the aggregate be clean in appearance, but it also should be subjected to actual test. Sand which passes even close inspection has been found in a great many cases to fail to set properly in mortar or concrete. A very small, almost insignificant, quantity of vegetable matter in the sand—a quantity which cannot be determined by the eye—may prevent the concrete from hardening. An especially good, fine aggregate is particularly necessary in the wearing surface of a pavement, because of the extremely hard usage to which it may be subjected. It is absolutely necessary, therefore, in any pavement used as a wearing surface, to test the sand. A mechanical analysis test is of value to determine the quantity of very fine material, which is especially detrimental to a wearing surface. In addition, however, there should always be a test of the strength of the mortar, made up into briquettes, or cubes, in the proportion of 1 part cement to 3 parts sand, and these specimens should be compared with similar ones made with the same cement and standard Ottawa sand. For the fine aggregate for a wearing surface, the strength of the mortar containing the sand in question should equal that of the standard sand mortar.

DISCUSSION BY PHILIP P. SHARPLES⁶

In the application of refined tars on old concrete pavements, the question of adherence is very much harder to solve than in the case of new pavements. On many pavements where there is a great deal of dust, both brought on and due to the actual grinding up of the concrete, it is extremely difficult to obtain a clean surface on which to put the tar.

If the pavement is dampened before the application of the refined tar, it is very important that absolutely all traffic be excluded until there has been a chance for the moisture to dry out from under the surface of the tar. Otherwise the tar does not adhere well, loosens, and will not give good results. In dampening the pavement no free water should be left on the top of the concrete, for in that case, the water tends to float the tar, preventing a good bond. The concrete should be allowed to dry partly, be

⁴Member Am. Soc. C. E.

⁵Transactions, Am. Soc. C. E., Vol. LXI., p.

⁶Chief Chemist, Barrett Mfg. Co., N. Y. C.

squeeged off, or treated in some other way so that no excess of moisture remains.

The tar should be applied in two thin coats. A slight coating of sand or screenings over the first coat is necessary, in order to allow the second coat to be applied. The second coat is filled with sand, screenings or pea stone. In this way a surface about $\frac{3}{8}$ or $\frac{1}{2}$ in. thick is built on top of the concrete. To insure a good wearing surface, it is essential to embed in the tar a hard mineral matter which will resist abrasion.

In repairing old concrete pavements, pot-holes must be considered. It is absolutely impossible to repair pot-holes with cement-concrete in an economical way. It has been found satisfactory, however, to use tar concrete, but, in doing so, it is important to use stone which will be practically as large as the hole is deep. If fine material is used, the traffic will soon force the tar mixture out of the hole.

DISCUSSION BY L. P. SIBLEY*

It has been suggested that the concrete should be moistened immediately before the application of the bituminous material. It seems to the speaker that there is a great difference between the entire body of the concrete being damp, or dry, and simply sprinkling the concrete immediately before applying the bituminous material. If the entire body of concrete is damp, it seems as if the results must be at least uncertain; but if it is dry, the moisture caused by the light quantity of water sprinkled on the surface would be sufficiently absorbed by the concrete so as not to interfere with the bond between the latter and the bituminous material. The road should be kept closed to traffic for a few hours in order to permit of this absorption.

In the case of bonding between the two layers of tar, when the first layer has been covered with screenings of sand, it is very important that these screenings be free from dust or any fine material, no particle of which should be less than $\frac{1}{8}$ in. in size. When the bond is thus constructed, there will be no blanket of dust or fine material over the first layer of tar to prevent the second layer from uniting solidly with it.

DISCUSSION BY SAMUEL WHINNERY*

In the speaker's opinion, every concrete roadway pavement should

be laid in two courses—a foundation and a surface course. The same functions are required as in other pavements, that is, strength to support loads, and density and hardness to resist surface abrasion.

The surface course of a concrete pavement should be compounded and laid with something like the same care, skill and thoroughness as the wearing course of an asphalt pavement. As a rule, this has not been done. Where the second or top course has been used, it has been laid more or less carelessly, with insufficient regard to quality of materials, uniformity of consistency, and thorough work.

Concrete pavements are not suitable for streets of heavy travel. They should never be used where a foundation of 4 in. of ordinary concrete and a surface course of 2 in. of special surface mixture, will not be ample to carry the loads and stand the abrasion of travel. There are, in every city, a large number of streets on which a properly constructed concrete pavement will give entire satisfaction. On such streets it will prove durable, dustless, possess most of the desirable qualities of a first-class roadway pavement, and give a larger return per dollar invested than any other kind of pavement.

The speaker agrees with Mr. Thompson in regard to the necessity of using only the best materials, and of giving special attention to the quality of the sand, which should be thoroughly tested. The hardness and toughness of the stone used in the top course is also an important consideration. The speaker specifies that the size of the stone shall range from that which will pass a screen of $1\frac{1}{4}$ in. mesh to that which will be held on a screen of $\frac{1}{2}$ in. mesh. The fine material and dust are objectionable, because of their tendency to segregate in the mass and because varying quantity is likely to prevent that uniformity of mixture which is highly desirable. He requires that the sand shall be screened, that it shall be of grains of such size that 75% of the whole will fail to pass the No. 30 sieve, and that it shall be tested with regard to the strength of mortar made with it. This is important in view of recent unsatisfactory experiences with apparently good sand. A ratio of 1 part of cement to 2 parts of sand for the mortar is probably rich enough. In some recent specifications the speaker has called for ratios of 1:3:6 for the foundation course and 1:2:3.75 for the surface course, but in the compacted mass the volume

of mortar should exceed that of the voids in the stone by from 7 to 10 per cent. The ideal surface-course mixture is one in which the largest practicable ratio of the mass is stone with sufficient strong mortar to hold the fragments in place. The speaker tries to insist that this surface mixture shall possess great uniformity in composition and consistency. This requires careful measurement of all the materials, including the water; that special care be taken to prevent segregation in the mixer or on the street; and that it shall be properly and uniformly graded and compressed to a true surface on the street; in short, that especial care shall be taken to make a concrete as nearly perfect as possible.

It is very important that the surface course be laid and tamped on the foundation course before either begins to set. This requires that the construction of the two courses be carried on simultaneously.

ROLL SURFACE COURSE

The surface course should be finished with a roller, not only to perfect the consolidation, but to secure a true surface, which latter is nearly as important as in the case of asphalt pavement.

Finishing the surface with neat mortar or by troweling should be prohibited.

Our knowledge relative to expansion and cracking is as yet meager. Concrete pavements often crack where apparently ample expansion joints have been provided and frequently where least expected. Where these natural cracks or joints occur, the wear along their edges, as a rule, is less than along those of artificial expansion joints. This is probably due to the fact that the wood or metal forms used for making the joints prevent the same uniformity of composition and density of the concrete along them as in the body of the work. To prevent this, it is better not to use such joint forms, but to cut the expansion joints through the concrete after it is laid. It is an open question at present whether it is not better to omit all expansion joints (except along the curb) when the pavement is laid, and to let the concrete select and make its own expansion (or rather contraction) joints. These cracks should then be filled with bituminous cement, after being cleaned out as well as possible with proper tools and by water jets from high-pressure hose.

The question of the advisability of applying a coating of asphaltic oil to the surface of the pavement,

*Asst. Eastern Mgr., Barrett Mfg. Co., N. Y. C.

*Member Am. Soc. C. E.

is not yet settled, but there is every reason to believe that, if suitable material is used and the work is properly done, it will be decidedly advantageous.

DISCUSSION BY WM. M. KINNEY

From the examination of more than 100 concrete pavements, during and after construction, in various sections of New York, Pennsylvania, Maryland, and other States, the speaker has come to the conclusion that the use of bank-run material or crusher-run limestone is almost sure to result in failure. The aggregates should be screened dry over a No. 4 screen and remixed in the definite proportions desired. A mixture of 1 part of cement 2 parts, sand, and 3 parts of gravel or crushed stone (from $\frac{1}{4}$ " to 1" in size), will give the best results under general conditions. Though a 1:2:4 mixture might be considered better to fill the usual requirement of the ratio of fine to coarse aggregate, the excess mortar in a 1:2:3 mixture will be a distinct advantage in finishing, and under most conditions, will be satisfactory.

This, of course, presupposes a one-course pavement, which should be selected in all cases where the aggregate available, in the territory in which the pavement is to be constructed, is suitable for a wearing surface. Good practice would recommend the two-course pavement only in places where local aggregate was suitable for the base concrete, but not for the wearing course. In such cases, the cost of the pavement might be reduced considerably by shipping in only enough of the more satisfactory aggregate for the wearing course.

PROHIBIT USE OF TROWELS

The use of steel trowels on a concrete pavement should be prohibited. The wooden float used after the concrete has been struck off to the proper grade with a straight-edge is amply sufficient, and does not draw the fine material to the surface like the steel trowel. The presence of fine material on the surface is objectionable from the wearing standpoint, and also because of increased slipperiness.

Regarding bituminous coatings, the coating will wear off sooner or later, and the concrete must be laid with the same care and attention as if no surfacing were to be applied.

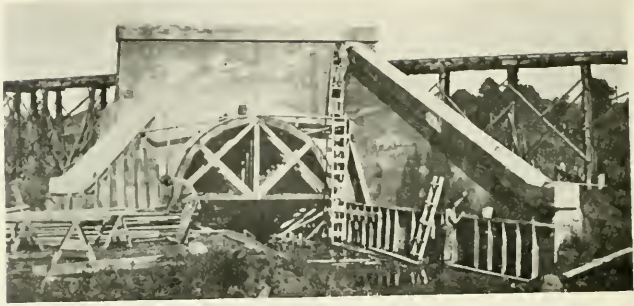


FIG. 1—CONCRETE CULVERT WORK ON CHARTIERS SOUTHERN RY.

Stone Crushers in Concrete Work.

The Chartiers Southern Ry., a 22-mile stretch of railroad, being built by the Pennsylvania System, extending from Van Emmon, Pa., to West Zollarville, Pa., runs five miles west of Pittsburgh. The object is to shunt through freights around Pittsburgh, without having to send them through Pittsburgh transfer. This applies more particularly to the heavy coal and coke trains, from the mining territory tapped by this railroad.

J. T. Hunter & Co. are the concrete contractors on sections 9, 10 and 11. They have been able to work without interruption since June 1, 1913. They are now ahead of their contract, and bid fair to secure other work next spring on adjoining sections.

The concrete arch shown in Fig. 1 is 165' from wing to wing. It contains approximately 2,500 cu. yds. of concrete. Owing to the distance from the nearest railroad and the fact that there are no sand deposits through that section, it was necessary for the contractor to install a stone crushing and sand crushing outfit.

Fig. 2 shows a No. 3 Wheeling

forced feed crusher¹, with 22-ft. pipe frame folding elevator, mounted on steel trucks. This crusher is adjustable by the turn of a hand wheel, to crush everything as fine as $\frac{1}{2}$ " and down, or as coarse as 2 $\frac{1}{2}$ ". The capacity of the crusher, when crushing rock for the concrete, is about 100 cu. yds. a day. With the jaws set to $\frac{1}{2}$ " for sand crushing, the capacity is about 40 cu. yds. to 50 cu. yds.

Mr. Hunter has a very unique arrangement for washing the sand, and at the same time, piling it where it will be handy for the concrete mixer. He has a trough set on about a 3% incline, about 100' long. The material drops onto a sand screen, into the bins, and the over-size into sand rolls, and everything that is sufficiently fine is washed by means of a constant stream of water, into the settling troughs. The dirty water is the over-flow, and the remainder is shoveled from these troughs into a storage pile.

All of the sand and rock for this contract has been produced with a crusher, and all the concrete has been mixed with a $\frac{1}{2}$ -yd. mixer.²

¹Wheeling Mold and Foundry Co., Wheeling, W. Va.

²Ransome Concrete Machinery Co., Dunellen, N. J.



FIG. 2—STONE CRUSHING PLANT ON CONCRETE CULVERT WORK

A Review of Some Recently Issued Patents in the Concrete Field

By LESTER L. SARGENT¹

The following notes pick out the salient features in patents recently issued covering development in concrete construction. Mr. Sargent skillfully handles the patents, grouping them to make up a complete structure:

A "House in Concrete" seems to have been the desideratum of nearly all the inventors to whom patents in the concrete field have been issued recently. These inventions have ranged from foundation to roof. Patents have been taken out on new floor construction in concrete, arches, walls, window frames, skylights and shingles, of plastic construction. Below is a brief review of recent progress in this art, which emphasizes the passing of wood in building construction.

A SHINGLE CAST IN PLACE

Reversing the usual procedure and beginning at the top, we come to the patent No. 1,075,403, issued to Frederick B. Cole, Longbeach, Cal., for a concrete-shingle mold. With this invention shingles may be formed directly on a roof and in separate or independent courses, thus providing for the contraction and expansion of the shingles without injuring the roof structure or cracking the shingles. Moreover, successive independent courses of shingles may be formed without waiting for the previously laid courses to set or

Larden. The invention consists in the combination of a series of mold boards adapted to be placed one above the other in overlapping engagement. To the upper surface of these mold boards cleats are secured, to limit the overlapping engagement. The transverse cleats are of less length than the width of the boards and terminate at the upper ends a short distance from the upper edges of the boards, to form stops to support the boards. To the lower surface of the mold boards a series of creasing members is secured to form creases in the shingles, to imitate the crack or space which occurs between the wooden shingles of a roof. Finally, means are provided to separate the courses of shingles formed by one of the mold boards from the courses formed by the preceding boards, and also shingle fastening rods adapted to be secured at their upper ends to the roof and to be embedded in the courses of shingles when the latter are formed, thus independently fastening the courses of shingles to the roof. This is shown in detail in Fig. 1.

CONCRETE WINDOW FRAMES

George Fletcher Mills, Cottage-hill, Fla., has been granted patent No. 1,075,928, covering a mold for concrete window frames, and means by which the sash pulleys and weights may be disposed in the concrete frames. It consists in a knock-down frame mold, so that when the concrete is placed around the frame mold and set, the sash pulley bracket may be freed from the frame mold

and the frame mold may be taken apart and removed, with the sash pulley bracket remaining in the frame formed in the concrete by the frame mold. Two adjacent removable core members are also provided, one disposed under the sash pulley bracket and spaced from the frame mold and the other extending downward at the side of the sash pulley bracket. An additional removable core member may also be provided.

A TILE FLOOR CONSTRUCTION

A floor construction, shown in Fig. 3, is the invention of Henry H. Vought, Jr., Williamsbridge, N. Y., patent No. 1,074,760. It comprises hollow tile open-ended blocks arranged in rows and spaced apart, the

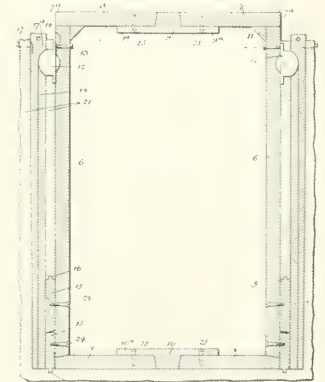


FIG. 2—A REMOVABLE FRAME AROUND WHICH A WINDOW CAN BE CAST

blocks having upper and lower spaces, the lower closed sides of the blocks projecting. Complementary small blocks are also provided, arranged to form a two-way system of crossing T-channels, in combination with crossing concrete T-beams formed in those channels. One-third interests in the patent rights are owned by Frederick Squires, Plainfield, N. J., and Asher Atkinson, New Brunswick, N. J.

A NEW WATERPROOFING COMPOUND

A new plastic waterproof trowel-compound is the invention of A. C. Horn, N. Y. C., patent No. 1,074,364. It is intended for the treatment of structural surfaces, including brick, concrete and other forms of masonry more or less porous and moisture-transmitting in character, to render them impervious to moisture. The compound may be troweled on a surface and worked into its irregularities and will adhere well even to damp masonry, and the patentee claims that it will form a continuous waterproof-

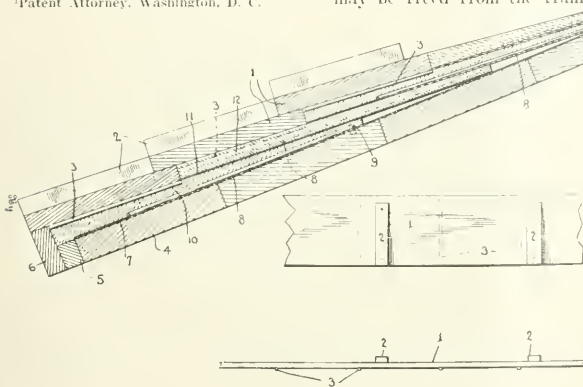


FIG. 1—DETAIL OF MOLD USED TO CAST SHINGLES IN PLACE ON THE ROOF

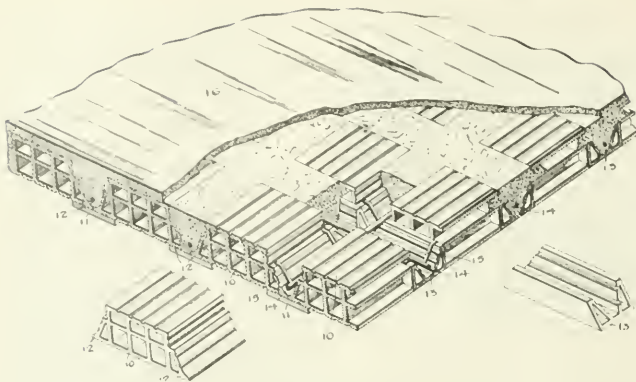


FIG. 3—DETAIL VIEW OF VOGHT T-BEAM

ing sheath over any surface however rugged, uneven or irregular it may be. The composition is in the form of a heavy paste, thick and coherent enough not to drip under the trowel, and of sufficient body not to sag after application, but spreading freely and smoothly under the trowel. Applied to expansion joints in concrete, this composition will expand and contract with the movement of the concrete slab. It may also be used effectively on roofs, under roof tile, or for repairing leaky areas. It has a peculiar irresponsiveness to temperature fluctuations, which augments its usefulness. Here is the formula: A thickened oil basis consisting of 70 parts of Chinese wood oil, 10 parts of boiled fish oil and 20 parts of asphalt is mixed with 40 parts of a thick paste of ammonium stearate in aqueous media. Seventy parts of hydrated lime or Portland cement are then added, with thorough agitation. To this composition filling or extending material may be added, provided the consistency be not increased to an excessive degree. Among the fillers which may be employed are bodies of the nature of talc or ground soapstone, whiting, barytes, china clay and kaolin, silice and the like. The proportions here given are expressed by volume.

A SECTIONAL CONCRETE BUILDING

A sectional concrete building has been invented by Carlo Zeimet, N. Y. C., patent No. 1,072,293, in which substantially uniform building blocks of concrete are employed. Certain of the blocks which comprise the building are arranged vertically and edge to edge and have shoulders arranged on their opposite edges, forming seats. A pair of lintels is arranged with the members in alignment with each other and has adjacent ends resting upon the seats formed by the shoulders provided

in the blocks. An interesting feature is that the blocks are numbered, each unit as applied to a window, for example, comprising six blocks numbered 1 to 6 inclusive. Each unit, or what may be termed "building section," comprises a definite number of elements or blocks and has a uniform dimension throughout the building. Each vertical edge or surface of a building element which is to be connected to an adjacent vertical surface is provided with an approximately V-shaped groove. The grooves of adjacent elements mate and when the blocks are assembled are filled with a plastic cement, which when set or hardened constitutes a rigid and durable connection for the parts of the building.

CONSTRUCTION USING A SMALLER UNIT

Another type of concrete construction for buildings has been patented by Francis H. Howard, Houston, Tex., No. 1,072,230. The Howard building is formed of double walls, with an air space between the walls, thus preventing the absorption of moisture and keeping the building dry. The structure does not of course have the undesirable weight of a building in which solid concrete blocks are employed. The parts of the wall and building are secured together by means of simple and secure joints, designed with a view to coupling strength with simplicity. A construction is provided consisting of a concrete base and concrete studding the lower ends of which are embedded in the base, a means (rods) engaging with the studding upon which the studding are adjustable, for fixing the position of the studding relative to each other, and wall slabs extending from one studding to another and spaced apart so as to form a double wall the ends of which dovetail with the studding.

Soapy Water For Waterproofing Concrete

Recent experiments at the laboratories of Gross-Lichterfelde, Berlin, on concretes and mortars have shown that the employment of soapy water is effective to assure the density of beton. Such soap solutions, however, have a bad influence on the hardening, although this danger can be avoided and absolute security obtained by an addition of trass in the mixture. The literal text of the conclusions of the experiments is as follows:

1. The addition of trass generally retards a little the hardening of mortars and concretes. It has a very good influence on the hardening of mixtures prepared with lime water and reduces the dangerous influence of soapy solutions, but it adds principally to the density.

2. Lime water has no effect on the resistance and the density of mixtures prepared without the addition of trass. It helps the hardening of those to which trass has been added.

3. Solutions of soap injure the phenomena of hardening of mixtures to which trass has not been added. Their dangerous influence is more or less attenuated by an addition of trass. Soapy solutions nevertheless develop dense mortars and betons.

A Good Precaution For Deep Water Tremie Work

At the recent meeting of the Am. Ry. Bridge and Building Assoc., G. W. Rear of the Southern Pacific R. R., pointed out a simple but effective method of operating a tremie in deep water. Heretofore in such work the most difficult part of the operation has been in filling the tube at the start. Unless the tube is sealed in some way the cement will wash out during the downward passage and leave only a pile of stone and sand. This waste of concrete may in the case of a 12-in. tube 50' long amount to more than 1 cu. yd. The method Mr. Rear suggests, and which he has tried out successfully, is to start with a 7-in. or 8-in. layer of planer shavings covered with about 1" of cement. As the concrete is dumped on top of this plug the buoyancy of the plug and resistance of the column of water underneath prevent the first concrete from falling rapidly enough to wash out the cement. After the first batch is placed the concrete itself acts as a seal.

Notes on the Use and the Cost of Concrete Pedestal Piles

In a thesis submitted for the degree of B. Sc. at the Georgia School of Technology, Atlanta, Ga., Walter Grady Miller presents a comprehensive report on the foundation for the Fulton County Courthouse, Atlanta. After discussing the general features of the building, the nature of the sub-soil, etc., he describes in detail the pile foundation.

The essential duty of the pile, according to the thesis, is to transmit a certain load which cannot be carried by spread footings on account of unreliable ground, to the firmer and more reliable sub-soil. It performs this duty by its direct bearing on the sub-soil under its base, and by the friction of its surface with the soil penetrated.

In the first case, the pile acts as a column loaded at the top by the footing, and transmitting its load to the firmer sub-soil at its base; in the second, the frictional resistance is transmitted to the sub-soil by a conoid of pressure. If the intermediate soil between the upper and the lower end of the pile happens to be a very soft clay or quicksand, the frictional resistance will be greatly reduced, and the load carried will depend chiefly on the bearing area developed by the base of the pile. It is thus seen that the pile with an enlarged base is in many cases a necessity while in many cases it is from certain points of view advantageous to use such a pile.

THE WORK AT ATLANTA

The successful bidder for the pile foundations on the work described was the MacArthur Concrete Pile & Foundation Co., which has developed

in the last few years the pedestal pile. The essential feature of this pile is an enlarged base. In constructing this pile a heavy cylindrical casing is driven to the required depth, usually to refusal under a specified number of blows of definite weight. A batch of concrete is then placed in the hollow cylinder, to be followed by a rammer. The cylinder is raised a little and the rammer is driven downward, enlarging the base of the pile into a bulb or pedestal. This process is continued until a base of required size is developed, after which the vertical pile is completed by filling the cylinder with concrete and gradually withdrawing the casing.

One advantage of the enlarged base pile over the ordinary taper pile lies in the fact that the latter has a tendency to be "driven down" as a post with a sharpened end drives much more easily than one with a blunt end. An enlarged base pile, on the other hand, strongly resists any "driving down" action.

METHODS USED IN PILE DRIVING

The pile driver used on the Atlanta work consisted essentially of a steam hammer, suspended between two heavy timber uprights, which served as guides to hold the hammer in the proper position while raising or lowering it. The bottom of the hammer cage connected to the top of the core and the casing. The core was driven until 10 blows caused not over 1" penetration. The piles were so designed and placed that with the dead load and 50% of the live load on the building each pile would have approximately 25 tons on it.

Forty piles out of the total number driven were tested. The maximum settlement under a maximum test load of 50 tons was $3/16"$. Some piles were tested under a 35-ton load only. The tops of the piles were required to be of various elevations in different sections of the foundations, due to a sub-basement, boiler pit, etc., having low floor elevations. Under most of the footings, piles were staggered about 3 ft. on centers in order to get the required number within a minimum area, and this reduced the size of the pile cap covering them. In all cases, the center of the piles was required to be 1' 6" from the edge of cap. Accepting 25 tons as the approximately correct load to be carried by each pile, the foundation of piles will carry (when the building is about 50% live loaded) something like 1,220 x 25 tons, or 30,500 tons load. The cost of these piles was for the first 15' driven, an average of 85 cts. per vertical ft. For depths greater than 15' a handbook issued by the MacArthur Concrete Pile and Foundation Co., states that as a rule, the prices will vary from \$1 to \$1.25 per lin. ft. of pile. For a very small or a very large job, however, the cost may run respectively higher or lower. In general the price per lin. ft. of the pedestal pile is as low as that of any other cast-in-place pile, and much lower than that of the cast-above-ground pile.

The Use of Pails for Measuring Cement

The remarkable development in small batch mixers within the last few years has brought up the question of finding ways and means of measuring accurately the cement required for the smaller batch. In the average run of work a sack or 95 lbs. of cement is too great an amount for a batch and contractors are facing the necessity of using fractions of a sack.

In order to develop information on this to find out what is actually being done CONCRETE-CEMENT AGE has written a number of contractors and manufacturers. In this connection, A. T. Scannell, pres., the Archer Iron Works, Chicago, writes that he recommends to the users of his company's mixer the purchase of a pail which holds exactly $1/2$ of a sack of cement. Several builders using small mixers are doing this. Where the cement required is $2/3$ of a sack or $3/4$ of a sack, the best method is practically to bulk the cement, as it were, dumping it into a wooden box and "pailing" it out as required.



A 50-Ton Test on a Concrete Pile at Atlanta

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

How to Clean Concrete from a Mixer

"What is the best way to clean concrete from a mixer? We have run it all the season and want to clean it up before storing away for the winter."

By MR. ALLING

As to the best method of cleaning concrete off a mixer before storing it away for the winter, we have known of only one method and that is applied to all types of concrete mixers. A chisel and hammer are used to remove the thickest of the concrete and then it is gone after with the pointed end of a file for a finisher. It is an arduous task at the best to get a concrete mixer thoroughly clean.

After the concrete is removed in this manner as thoroughly as possible, it is good practice to apply crude oil with a brush on the inside of the mixing compartment. This will keep the mixer free from rust and otherwise in a good state of preservation.

By MR. SIMPLER

While the following notes apply especially to the small batch mixer made by our firm, yet in general they should apply to any small mixer. Our suggestions are as follows:

After the mixer has been pulled inside, out of the weather, take the bolts out of the engine house and remove the housing from the engine.

DISCUSSED BY:

W. ALLING¹

W. B. SIMPLER²

A. W. RANSOME³

PAYNE G. WEST⁴

Then loosen the set screws in the mixer drum and remove drum from the frame. The entire outfit is then accessible for any cleaning that may be desired.

THE USE OF COAL OIL

Then take a can of coal oil and a paint brush and simply give it a good coat of oil and wipe off the engine in a careful manner. Remove the caps from the bearings and clean them well. After the coal oil has been rubbed off, brush the engine with gasoline, and then oil all parts with heavy oil, some sort of an oil that will not run off.

The coal oil will by this time have cut the concrete that has been sticking to the various parts of the mixer drum, and it can then be easily scraped off with any old file that is sharp on one end. After the concrete has been all scraped off, give it some sort of a heavy paint, something like asphaltum, which will prevent any rusting through the winter. Then put the mixer drum on, as well as the engine house, and the mixer will be in as good a condition next winter as when it was purchased.

By MR. WEST

In the first place, take a hammer and a cold chisel and clean out all of the concrete which has become embedded in the corners of the machine, and knock off all of it that has adhered to the outer exposed

surfaces. Then take a stiff wire brush and go over all of the surfaces which have had concrete upon them. This will eventually clean off all that adheres to the metal. The machine can then be washed thoroughly and after it dries all of the surfaces should be given a good coat of mineral paint to protect them against rust. Black asphaltum paint of a good grade works well. Take all of the running parts, such as gears, main rollers, axles, etc., and cover them with a thick coating of grease. The bearings themselves should be well greased, otherwise the moisture will rust them and they will be found frozen when operations open up in the spring.

If possible the machine should be under cover in winter. If, however, it is necessary to leave it outside, it should be protected as much as possible. It is a good thing to take some loose boards and stand them up against the machine, sloping them so that they will shed water.

One of the most important things in leaving a machine for the winter is to be sure to drain the water tank, and the cylinder of the gas engine, opening the drain-cock so that no water can possibly settle and freeze. If equipped with engine and boiler, they should be absolutely drained.

When a machine is taken care of in this way it will be found in first-class condition when operations start in the spring. With a few hours' work cleaning off the surplus grease and in putting in fresh grease, the machine should be ready to operate.

By MR. RANSOME

The best method of cleaning a concrete mixer is "to keep it clean." It is an extremely simple matter to prevent an accumulation of concrete on a mixer, if proper care is taken of the machine from the beginning, and it is a difficult matter to keep a

¹Eureka Mach. Co., Lansing, Mich.

²Sales Manager, Eureka Mach. Co., Lansing, Mich.

³Vice-Pres., Ransome Concrete Mach. Co., Dunellen, N. J.

⁴Sec. Chicago Concrete Machy. Co., Milwaukee

machine clean, once concrete has been allowed to accumulate either inside or outside of the drum.

When the writer was engaged in concrete construction work, he made it an invariable practice to allow the man in charge of the mixer one-half hour extra time each day for the purpose of cleaning up in and around the mixer, and this extra time invariably proves a profitable investment, in that the mixer is always in good working order, and the wear and tear on moving parts are reduced to the minimum. Before starting operations, it is advisable to slush or paint the mixer with "Petrolatum," or other suitable grease which will prevent the concrete from adhering to the metal. Upon shutting down at night, the machine can readily be hosed clean in a few minutes, and an occasional application of the grease will make this method continually effective.

With regard to the interior of the drum, it is important that water be fed to the machine through the feed opening and it should in all cases be fed into the mixer directly against the end wall of the mixer drum and in advance of the aggregate and cement. If this is done, the water will prevent the accumulation of concrete inside the drum. If, however, the aggregate gets in first, concrete will most certainly accumulate, and once having accumulated, there is no remedy other than a hammer and chisel, and the job should be thoroughly done, after which the exterior of the machine should be greased as recommended above and it would be a good thing to slush the inside of the drum as well. The grease remaining on resuming operations in the spring can be readily removed by turning the machine over a few times with say one-half batch of sand and water.

Washing Crushed Stone

"How can dirty crushed stone intended for reinforced concrete be washed easily, quickly and economically without using a concrete mixer? I have found that to use a mixer for such work is not economical. Probably some of your readers can give me an illustration and description of

a round conical screen that can be turned, preferably by hand, where the crushed stone could be shoveled into the small end by hand and a hose with a strong stream of water held on it. The stone is rolled over and over and comes out of the large end clean."

DISCUSSED BY E. E. DILLON¹

The accompanying sketch shows a crushed stone washer which I have used and found satisfactory. It is constructed as follows:

A is a wooden frame of 6-in. x 6-in. timbers. *B* is a hopper made of 1-in. boards. *C* is a 2-in. iron pipe for a shaft with a crank *I*, bearings *J*, sprockets *D*, and thrust collar mounted upon it. *E* is a round screen made of $\frac{3}{8}$ -in. round rods spaced $\frac{3}{4}$ in. c-c; the lower frame of the screen is an old iron pulley 12" in diameter, with 2-in. face having the hub bored out to receive the 2½-in. iron water pipe and a thrust collar *H* is mounted upon it to hold the drum in place as it revolves. A 1-in. x 1-in. angle is bent around the face of the pulley with one leg of the angle pointing towards the center and having holes to receive the rods; the middle and the upper frames are made of 1-in. x 1-in. angles bent to the same diameter as the lower end and have holes to receive the rods. Two sprockets having their arms sawed off 1" from the rims and 1-in. x 1-in. angles bolted on either side of the arms and on the inside of each sprocket is bolted a

1-in. x 1-in. angle with one leg pointing towards the center and having holes to receive the rods. The sprocket chains support the screen, and the iron pipe inside of the screen has a large number of 3 16-in. holes along the lower side and in such a position that the rock, as it rolls through the screen, will receive the full force of the water, that is fed in at the hose *G*. The length of the screen is 8'. If rock is extremely dirty it may have to go through the screen twice.

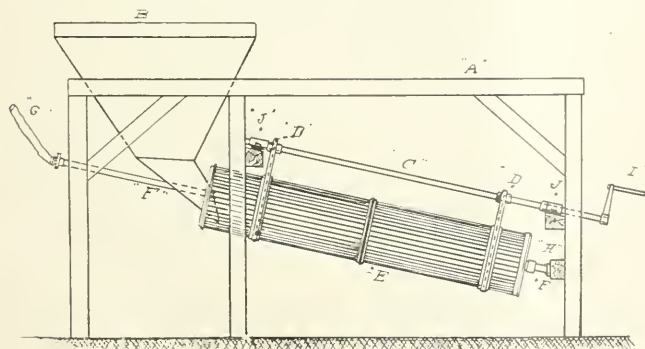
Failure of a Sidewalk Surface

"Some time ago we put down a 10-ft. sidewalk in front of a business house. We used a 1:2 mixture for the top coat; the surface was well troweled and looked like a first-class job. About two weeks after it was opened for traffic, however, the surface began to scale and peel off.

"What we want to know is this: Is there a coating of some kind that could be applied over this top (which is rough) that will give it a smooth, hard finish that will wear well and give good service? The walk is covered by an awning its entire length, so that there will be but little water on it, if any."

DISCUSSED BY J. D. CAREY¹

In resurfacing a sidewalk, I should advise that the surface of the walk be crandalled and washed off with a strong pressure hose, giving it as much water as it will take. Use an approved binding material, if procurable; if not, use pure cement well brushed on and slushing should precede immediately the placing of the top coat, which should be run rather sticky and rammed thoroughly. The top coat should then be floated, troweled to a finish, and cov-



SKETCH ELEVATION SHOWING A HOME-MADE MACHINE FOR WASHING STONE

¹Concrete Contr., Cleveland

ered with damp sand about 1" deep. This sand should be kept damp on the surface about one week. By following these directions carefully 1/2" of a top coat should be sufficient to give a perfect job, but a full inch, if it can be obtained, would be still better.

Dusting of Concrete Floors

Editor's Note—How to prevent dusting is a problem which needs no specific question as an introduction, for it is one which many concrete contractors have to face. The better methods developed, as they come into more general use, will ultimately eliminate what has proven, in many cases, a serious difficulty.]

DISCUSSED BY G. HAISS¹

We have tried out several materials for waterproofing and wear-proofing our floors and have found from actual tests that the best we could use was boiled linseed oil thinned with about 20% benzine when applied, to draw the oil into the floor. We have used this on our buildings and it has worked very well. It has obliterated all the dust, and has formed a solid covering on top of the floor, which we think will last us a number of years before it will need any renewing.

As the oil and the benzine are very reasonable in price, we think the mixture would be a good thing to use wherever something is required for dust-proofing concrete floors.

White Surface for Burial Vaults

"In finishing the inside of concrete burial vaults, I want to make the surface as clear and spotless as white as possible. What materials or wash should I use for this purpose?"

DISCUSSED BY F. C. PRINTY²

To make the inside of concrete burial vaults clear and spotless, a wash of waterproofed white Portland cement is recommended. The wash should consist of pure waterproofed white cement and should be of the consistency of thick cream. More satisfactory results can be obtained by building the vaults entirely out of waterproofed white Portland cement.

Concrete Pavement Surface on Grades

"We purpose putting in concrete pavements on some streets where there are grades exceeding 5%. What is the best treatment for the surface of the concrete on such grades with reference to foothold and to wearing qualities?"

By MR. MANDIGO

Regarding the selection of the proper surface for concrete on grades of more than 5%, I give below my opinion based on the experience of Kansas City, Mo., in laying concrete pavement on numerous streets of more than 5% grade, a great many of which were 10%, and some few from 12% to 15% grades.

All our concrete pavements are of plain one-course concrete, 6" thick, graded with hoes and shovels, thoroughly tamped and broomed with a fiber street broom, but neither tamped nor floated. Consequently, the stones lie in the concrete close to the surface; and on grades the surface is more or less uneven and slightly rough.

In fact, we have difficulty on steep grades (where the concrete is apt to creep before it has set) in getting it smooth enough. The results obtained give a surface with an excellent foothold for horses, on which there is not the least danger of automobiles slipping or skidding, except in an unusual condition of an ice-covered surface. A surface of this kind does not wear smooth on a grade, as it does on a level plane, and on pavement that is as much as two or three years old, we have had no complaints on account of slipperiness. Of course, there is no paved surface that gives so sure a foothold for horses as an earth road, but a concrete surface as above described is undoubtedly better than a vitrified brick or asphalt and is very nearly as good as the stone block or hillside brick.

By MR. WILSON

In 1912 I paved East State St. in this city, between Cedar Ave. and Mill St., with concrete, the width of roadway being 40' between the curbs, the grade being 5.2%.

This pavement, after being laid, was finished off with a wooden float,

which made a surface that gives sufficient foothold for horses and is not slippery and is without any corrugations which would eventually break down or wear off.

This pavement is on our main east and west thoroughfare, where it receives a heavy traffic.

On East Fifth St., in this city, between Cedar Ave. and Mill St., where the grade is 9%, I also paved with concrete, the surface being finished off with a wooden float, and the residents are satisfied and I haven't heard any complaints about this pavement being slippery or impassable.

I take a coarse-grained piece of soft wood and have it sawed with a rip saw, which makes the surface of the wood rough: a float is then made from this wood and when used properly makes a surface sufficiently rough to give ample foothold for horses and still not affect the wearing qualities of the pavement.

Neat Cement on Sidewalk Surface

"In sidewalk work, what is the advantage of floating cement on the top before the final finish? Doesn't this practice introduce many factors making for checking and a too slippery surface?"

DISCUSSED BY J. D. CAREY¹

Relative to the advisability of "Floating cement in tops of walks before the final finish," this dusting or shaking is done for the purpose of giving a smooth finish, quickly; also, to a great extent, to waterproof the surface. If well floated in, there is no possibility of checking, unless exposed to a hot sun, providing the cement is not too fresh or hot with lime. This shaking or dusting when well done improves the wearing sur-

¹Pres., George Hais Mfg. Co., Inc., N. Y. C.
²Sandusky Portland Cement Co., Sandusky, O.

¹Asst. City Engr., Kansas City, Mo.
²City Engr., Mason City, Ia.

¹J. D. Carey Co., Cleveland

face at least 50%, and, when required, can be brought to a very finely polished surface by the use of sour beer.

In outside work it is not necessary to leave the surface under a trowel finish, as it would be entirely too

slippery, but it can be left under a trowel float or a wood float finish, or heavily rolled and give all the desired results. Sometimes in very hot weather it is advisable to use 50% marble dust or fine sand mixed with the cement floated on the surface.

ever, more finely ground and requires in its mixture the use of more water. For facing concrete products, therefore, I would recommend the use of 1 part white Portland cement and 2 parts of white sand or marble dust, making a wet mortar, and having the thickness in the center of the block or brick not less than $\frac{1}{4}$ " and running from 1" to $\frac{1}{2}$ " at the ends.

These facings are usually applied in molds known as face-down machines, where the white mortar is placed in the bottom of the machine and the concrete poured in on top. This mortar, as stated, should be good and wet—say of a jelly-like consistency.

Care should always be taken regarding the curing of this character of block. The face should be carefully kept wet either in a steam chamber or by covering with wet cloths for at least three days, and should not be exposed to the changes of temperature before at least two weeks.

BY MR. NEWBERRY

There is practically no difference in the characteristics of our white cement and those of the best gray Portland, so far as shown by the usual tests. We find it necessary, however, to avoid obtaining a quicker-setting product, to use materials more high in silica and lower in alumina than those ordinarily employed for gray cement. The result is that the white cement is somewhat slower in setting and hardening than gray cements, and probably slower than the average of gray cement. There is no real drawback, as it is well known that slow-hardening cements are most permanent, and show the highest strength at long periods. Users can hardly expect quite as rapid hardening with white cement as with gray Portlands. This hardening can be greatly hastened, with any cement, by the use of calcium chloride solution of about 10% strength, instead of water in the mixing. This has no bad effect whatever, and is very useful in preventing shrinkage cracks in the work. Our white cement is also much more finely ground than gray cements, and therefore requires greater care, in keeping work covered and moist, to avoid hair-cracks, due to shrinkage from too rapid drying out.

Cummings Structural Concrete Co., Pittsburgh, has been awarded the contract for casting and placing reinforced concrete piles on work for the N. Y. C. & H. R. R. Co. near White Plains and Mt. Vernon, N. Y.

Comparative Materials for Dam Construction

"I want to get some idea of the comparative cost of reinforced concrete and so-called rubble concrete construction for dams. I would like to get some notes on the advantage of each type of construction and also the cost per cu. yd. and suggestions as to the method of handling."

DISCUSSED BY J. A. O'CONNOR¹

It would seem from the above information regarding the abundance of rock and boulders, that the class of construction best suited to the conditions would be a cyclopean masonry dam of the gravity type. The aggregate should be sand and broken stone obtained by establishing a small crusher on the site of the work, or gravel, if it can be obtained more cheaply. A standard brand of Portland cement should be used. If crushed stone is used as aggregate, it must be hard and clean and not inclined to flake off like shale or slate. A 1:2:2½:5 mixture would be suitable for this work.

Boulders of any size which can be easily handled may be thoroughly cleaned and embedded in the dam by working them down into the concrete to exclude all air pockets. Boulders should be perfectly sound, and should be placed so as to be not less than 1' from any face of the masonry, and should be separated from each other by at least 6" of concrete.

If at all practicable, the foundation should be placed on solid rock which has been thoroughly cleaned.

The construction of a rubble dam seems to be impracticable since it would require the highest class of workmanship and very careful inspection; and, even under those conditions, it is doubtful that such construction would be advisable.

I should not recommend reinforced concrete for the construction of a dam in a locality so plentifully sup-

"The specific case I have under consideration is the construction of a dam in a fairly accessible locality. There is considerable loose rock in the neighborhood and many large boulders. Sand would have to be hauled quite a distance and the cement would have to be hauled about ¼ miles."

plied with stone and boulders suitable for heavy construction.

It is impossible to state accurately the cost for such work; but it is probable that, if done by contract, the price would not exceed \$8.50 per cu. yd.

Finally, it is imperative that the services of a competent engineer be secured, who may go over the ground and decide on the proper section of dam to be used and the all-important question of foundation.

The Use of White Cement

"What characteristics has white Portland cement not common to gray Portland cement which are of interest to the user of this material for facing mixtures of concrete products and other ornamental work in a concrete products plant? We have in mind particularly the wetness or dryness of the mixture, the proportions, the finishing and the curing."

DISCUSSED BY:
EDWARD D. BOYER¹
S. B. NEWBERRY²

BY MR. BOYER

White Portland cement is being used successfully for facing concrete brick, block or any concrete product. Its characteristics are practically similar to those of the regular gray Portland cement. It is, how-

¹Terminal Engr., Dept. of State Engr. and Surveyor, Albany, N. Y.

²Atlas Portland Cement Co., N. Y. C.

³Sandusky Portland Cement Co., Sandusky, O.

Insulating Brick Walls

"I am building a brick and tile residence. The outer wall is face brick (impervious) with a 2-in. air-space and backed up with hollow clay tile $1\frac{1}{2}'' \times 5'' \times 12''$, laid on the 4-in. side, thus making a 10-in. wall. Where the courses come even across, the face brick is used as a tie, and, of course, being flush on the outside (Flemish bond work), lacks about 2" of reaching to the inside of the inner wall.

"This leaves small holes the size of the end of a brick, which will fill all right with plaster, if it is safe to do so.

DISCUSSED BY BENJAMIN A. HOWES¹

In regard to the possibility of interior condensation in the construction as outlined above, I want to say as a preliminary that no doubt in seven cases out of 10 the construction with solid plaster as described would be all right, but occasionally there are especially damp days and in some climatic conditions, the condensation suggested might occur.

It will be understood that bricks ordinarily laid cannot have all the interstices in and between them absolutely filled with mortar, and there is the possibility of letting water work into these interstices, and fol-

"What I fear is that the brick used as a tie will act as a conductor (together with the plaster at the end of the brick) and conduct the cold in extreme weather to a point on the inside of the finished and decorated wall where it would meet the heat of the room and form a condensation which might result in 'sweat' appearing at these points by reason of heat and cold coming together suddenly, as one sees it at times on the inside of a pane of window glass. If there is no danger of this, I shall certainly be glad to know. If there is danger then I would appreciate your recommendation as to its prevention."

low the impervious brick into the plaster. I have known of water following through a well built brick wall after a long-continued rain-storm, when the solid brick-work was 3' thick.

Therefore, I should advise that the recesses at the end of the bricks be covered up by any form of light weight wire lath, say a strip 1" to 6" wide, nailed over the recesses, so that when the plaster is put on there is a 2-in. air space between the brick and the plaster.

This will make a perfect job so far as insulation is concerned, with no great outlay above the value of the plaster which it saves.

"In this connection, we should like to know whether or not it is usual in the case of the cinder foundation being required, to demand that the cinders be passed through a $\frac{1}{4}$ -in. screen, assuming that the cinders are a good grade of factory cinders, with the usual amount of fine material, but free from waste or rubbish. We have been in the habit of using the cinders as they come to us, but we are now asked to screen them through a $\frac{1}{4}$ -in. screen, on the engineer's interpretation of the clause 'clean steam cinders' used in the specifications.

"Is the specification referred to not unusually strict, and arbitrary in general, and if required to be lived up to in its entirety, would it not make the cost of sidewalks laid in strict conformity with it a very expensive, not to say an almost prohibitive, job?

"We should be obliged for your opinion relative to the following terms from the sidewalk ordinance

under which we are now working:

'clean steam cinders'

'clean, sharp, screened sand' (used in the concrete)

'covering and keeping moist for three days'

"We are trying to have a change made in the specifications which will allow of good work at less expense than is entailed in laying the sidewalks strictly according to sample specification and your good advices, and those of correspondents will be appreciated."

DISCUSSED BY:

A. B. BAIRD²

IGN. BILODEAU³

BY MR. BAIRD

I believe the so-called cinder drainage foundation for concrete sidewalk is misleading. It might better be called a porous cushion without drainage. Very few sidewalks have any outlet or sewer connections for their bed. For several years I have been laying walk on the natural ground with good results. As it was not the usual way I had many critics who would shake their heads and look wise, but none of them have yet had the pleasure of saying: "I told you so." I am not posing as one who knows it all, but I do admire one who has the courage to ask Dad why he does so and so and expects a reasonable answer.

BY MR. BILODEAU

In the discussion of this question in the Oct., 1913, issue, p. 173, Mr. Bray is, in my opinion, right when he says that putting a gravel or a cinder foundation under a concrete sidewalk accomplishes just the contrary of what the engineer intends it to accomplish. I have laid concrete and flag sidewalks for over 40 years in the U. S. and Canada. These sidewalks are just as good as those sidewalks which we are now laying under specifications which require a sub-base, and show less cracking. I guarantee that the sidewalks I lay without a sub-base will not crack or settle so much as those laid with a sub-base. I base this statement on my long experience in this work.

In regard to wearing surfaces, we have found that the best surfaces are those that we put in when the weather was around freezing point. In the month of October and part of September, we put the wearing surface on between 4 p. m. and 7 p. m., and finish it early in the morning. This practice, of course, applies only to times when nights are not cold enough for the concrete to freeze.

Cinder Foundation in Sidewalk Construction

"We should be glad to hear from authoritative sources some expressions of opinion relative to comparative merits of concrete sidewalks with and without drainage foundation, using as a basis for comparison a $\frac{1}{4}$ -in. thick slab of concrete laid on a cinder cushion 4" in thickness, or a $\frac{1}{4}$ -in. thick slab of concrete laid on a solid dirt bottom, without any cinders or other provision for drainage. Our own experience has been that the latter method is equally as good as the former, if not a shade better, other things being equal as to material and workmanship, but we should like some expressions from engineers and others in the trade as to which of the methods, if any, is either considered standard, or tending to become so.

¹Engr. and Contr., N. Y. C.

²Belle Vernon, Pa.

³Paving Contractor, Quebec, P. Q.

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellows." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellows."

Covers a Smoke Flue With Concrete; Saves \$10

A LETTER FROM CHARLES F. CHASE¹

I have, on my account, done a "cement stunt" which may possibly be of interest to your readers. My boiler is located 10' from the chimney. Having noticed last spring that the galvanized smoke pipe was rusting so that it would not stand another winter, I covered it with reinforcing wire and then, with a 1:3 mixture, built up a cement smoke pipe which averaged about 5" thick on top, reaching to the terra cotta tiles forming the floor overhead, 1½" thick on the bottom.

The reinforcing wire had stamped metal strengthening ribs which I placed so as to run parallel to the length of the smoke pipe. Before attaching the reinforcing wire I placed around the smoke pipe snug rings of heavy wire and upon these rings the ribs of the reinforcing wire rested so as to enable the cement mortar to get between the reinforcing ribs and the smoke pipe, the idea being to protect the reinforcing ribs from corrosion, when, as is bound to occur sooner or later, the original galvanized smoke pipe disintegrates.

In order to provide against possible damage due to expansion on account of the heat, I placed on the vertical part of the galvanized smoke pipe toward the chimney several layers of corrugated paper so as to permit some movement without fracturing the cast iron collar on the boiler around which the smoke pipe is fitted.

The first coat of cement mortar

was placed May 24, last. The second coat and completion of the job were accomplished May 30. For the first week I thoroughly wet down the entire pipe twice a day with a hose. Owing to the fact that the pipe is located in the cellar and protected from the sun and breeze, the drying out was slow.

A CLEAN-OUT DOOR

In the center I made a trapdoor for a clean-out. To support the trapdoor I ran a length of heavy wire over the pipe so that when set in the cement and the ends brought together and twisted it would support the trapdoor at either end.

This trapdoor was made with a

piece of the reinforcing mesh of the right size (it was the piece cut out when making the opening). I greased the edge of the opening so that the cement used in making the trapdoor would not make a bond. This trapdoor I soaked in water for a week after it was made. The handle was made of heavy wire and was cast in the cement mortar. Little notches in the form boards were made to allow the wire handle to pass between them.

After the trapdoor was put in place and in order to make the joints more nearly airtight, I filled them up with a mixture of sand, lime and cement of such a proportion as to enable the joints to be easily broken when necessary.

In order to support the pipe when green I drilled a series of holes in the terra cotta floor in which toggle bolts were placed to which were attached heavy wires passed under the pipe. These wires were covered with

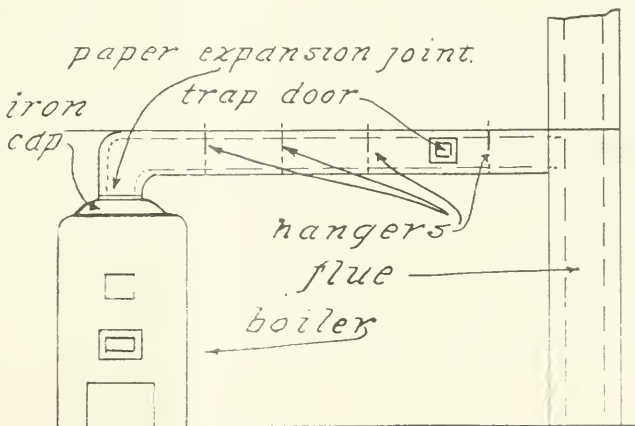


FIG. 1—ELEVATION SHOWING CEMENT MORTAR COVERED SMOKE FLUE IN PLACE
CONCRETE-CEMENT AGE

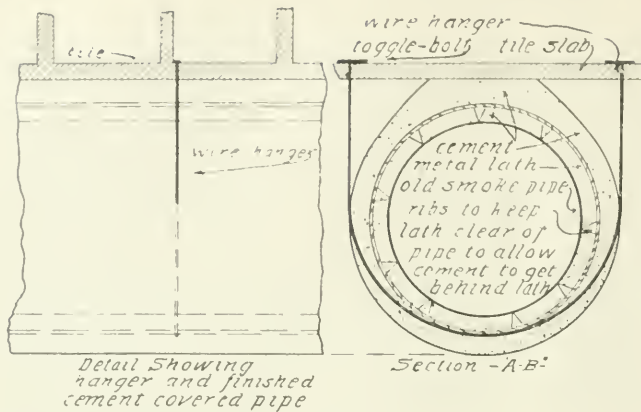


FIG. 2—DETAIL ELEVATION AND SECTION OF FLUE

cement during the progress of the work.

I have had a fire going since Oct. 14 and so far not the slightest evidence of cracking has developed. I see no reason why, now that the pipe has withstood the action of the heat up to the present without fracture, it should not last as long as any other permanent masonry connected with the house.

At the present writing (Nov. 18), more than four weeks after the fire was started, there is no evidence of cracking anywhere and neither is there any evidence that the cement mortar pipe is separating from the terra cotta tile floor up to which it is built.

The cost of the above, exclusive of my time, was about \$1.00. To have a plumber renew the galvanized pipe would have cost probably \$10 to \$12.

Artificial Travertine Stone Manufacture for Panama-Pacific Exposition

—A LETTER FROM H. M. WRIGHT*

One of the most interesting spots just now on the grounds of the Panama-Pacific International Exposition is the small structure, part studio and part laboratory, where the assistants of Jules Guerin, director of color, and Paul E. Danivelle, originator of the imitation Travertine rock which will form the outer covering of the exhibit palaces, are testing and experimenting with various tints and styles of this texture, not only for flat surfaces, but for columns, capitals, cornices and other details of architectural ornamentation.

The exterior appearance of the entire exposition will be one of great beauty from the color and texture standpoint. The Travertine rock, or marble, is a peculiarly beautiful stone found near the banks of the

Tiber river, in Italy, and it was of it that ancient Rome was built. The texture of the exposition palaces will be a correct replica of this rock, which is an agreeable substitute for the dazzling white plaster effects that have hitherto characterized the buildings of previous expositions. Instead of suggesting plaster and stucco, the entire exterior of the Panama-Pacific International Exposition will convey an impression of rare marble, soft in tone and color, and the stratified texture of its surface will give repose for the eye both by day and by night. It will have no distinct sharp color, but may be described as having several warm tones of grey and pink blended together, all an integral part of the mixture, which consists of sand, plaster and pigment.

The tone and horizontally stratified treatment will carry through all architectural forms and surfaces, in-

cluding all sculpture. Here and there a note of contrast will be obtained by integral castings of columns in replica of Red Sienna or Numidian marble, or a verde antique bronze and gold, but even here the relation will be felt by this special stratified treatment. By this method life and interest will be given the vast wall surfaces.

In the courts, additional color will be used on the walls behind the colonnades, with here and there spots of color occurring in the architraves and cornices, as well as in the various domes, half-domes and niches. The whole impression gained will be one of great richness.

Roman Travertine was first artificially represented in the new Pennsylvania railroad station in New York City by Paul E. Danivelle, its originator and the supervisor of the present exposition plastic scheme. The composition consists of a specially prepared gypsum product, colored in accordance with formulae furnished by the exposition company and manufactured in such a way as to be adapted particularly for exterior use.

Where cast forms are not used, the plastic composition is applied directly to the grooved sheathing of the structures. All cornices, architectural columns and decorative ceilings are cast from moulds and secured to a skeleton frame of wood. All stucco on flat surfaces will be two-coat work, the first coat being a base coat of chosen mixture, without color, with sand and fibre, the second coat a colored mixture with a suitable portion of sand and finished with the desired texture.

The same effects will be carried out on all cornices and moulded surfaces, which will be cast from the ready colored mixture. The procedure in manufacturing is to prepare glue molds in the usual manner. After the mold has been properly prepared, the first step is to lay on light and dark veins of liquid colored composition, which is done by means of specially constructed multiple veining cans. The second step is to lay on the semi-dry, or slightly damp, mixture, wherever the variegated indentations are desired. This mixture is just wet enough to take on a permanent set, and then a thin backing of the same mixture, but in a more liquid condition, is applied.

To make up the full thickness the mold is further backed up with uncolored mixture and reinforced in the usual manner with jute and fibre dipped in the liquid mixture, producing finally a cast varying from $\frac{3}{4}$ " to 2" thick.

*Panama Pacific International Exposition, San Francisco

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa. Convention, Chicago, Feb. 16-20, 1914.

American Highway Association, J. E. Pennybacker, Jr., Secretary, Colorado Building, Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co., 72 West Adams St., Chicago, Ill.; J. P. Beck, Sec. Seventh Chicago

Cement Show, Coliseum, Feb. 12-21, 1914.

Interstate Cement Tile Manufacturers' Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago. Convention Feb. 17-19, Chicago.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia. Convention, Ames, Ia., Jan. 8-10.

National Conference on Concrete Road Building, J. P. Beck, 72 W. Adams St., Sec. First meeting Auditorium, Chicago, Feb. 12-14, 1914.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb. Convention Feb. 2-4 and Show Jan. 30 to Feb. 4, 1914, Omaha.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

Chicago Cement Show, the Big National Exhibition, Feb. 12-21.

The best single opportunity of the year to catch up with the industry will be afforded in Chicago, Feb. 12-21. The main and central attraction of an educational nature will be the Chicago Cement Show—the one national exhibition of everything pertaining to the concrete industry of the year. Every space has, we understand, been sold for many weeks, and while in other years the efforts of exhibitors have been divided with two or more national shows, this year attention is well centered in one place. This is what makes an almost unprecedented opportunity to view the tools and the material with which the concrete industry works. At this same time, while the show is in full swing, there will be several meetings of the utmost importance in the field of concrete. There is the convention of the American Concrete Institute (formerly the National Assn. of Cement Users) for which a program is in preparation for Feb. 16-20. The National Conference on Concrete Roads, Feb. 12-14, undoubtedly will proceed a long way toward a standardization of concrete roads and pavements. The Interstate Cement Tile Mfrs. Assn. will hold its sessions Feb. 17-19. The

National Assn. of Sand and Gravel Producers will also meet, and conventions of the National Builders' Supply Assn., the Illinois Lumber Dealers' and Builders' Supply Assn. and the Illinois Assn. of Municipal Contractors are scheduled for the time of the Show.

All these meetings are sure to result in a concrete Congress in Chicago which will combine to make the Cement Show a success.

Convention and Exhibition, American Road Builders Association

The 10th annual convention of the American Road Builders' Assn. was held in the First Regiment Armory, Philadelphia, Dec. 9-12, inclusive, and in connection with it the association's fourth annual exhibition of road machinery and equipment was on view. About 2,000 registered in the secretary's office in the course of the four-day meeting.

Exhibition space for the show was well taken up and the meetings themselves had all the attendance which was possible in the space allotted for the convention.

First Day, Dec. 9—George D. Porter, Philadelphia's Director of Public Safety, made the city's ad-

dress of welcome on behalf of Mayor Blankenburg, and Governor Tener spoke for the state. President Samuel Hill, of the Association, made the response, after which E. A. Stevens, New Jersey State Highway Commissioner, presented a paper: "Highway Officials, Their Duties and Powers," which was discussed by A. N. Johnson, State Highway Engr., Illinois, the latter making special reference to the new highway law of his state.¹ S. Percy Hooker, State Superintendent of Highways, New Hampshire, presented the second paper on organization: "Division of Expense, Responsibility and Authority Among Nation, State, County and Town." Mr. Hooker spoke of the impracticability of the various proposed measures by which federal aid is to be extended in road building, admitting that while federal aid will come, it should not be after any of the plans so far presented to Congress. N. A. McLean, Provincial Engr. of Highways of Ontario, continuing the general subject of organization, commended the French system highly and proposed that it be studied by those seeking model organization and administrative method.

Second Day, Dec. 10—"The Relation to Each Other of the Contractor, Engineer and Inspector," a paper by F. L. Crawford, Crawford Co., Brooklyn, N. Y., continued the subject of organization at this session, and it was discussed by Maj. W. W. Crosby, ch. engr. Maryland Geologic and Economic Survey, Baltimore (his discussion being read in his absence); H. W. Durham, ch. engr., Bur. of Highways, Borough of Manhattan, N. Y. C.; Fred E. Ellis, mgr. Essex Trap Rock & Construction Co., Peabody, Mass., and by G. S. Webster, Chief of the Bur. of Surveys, Philadelphia. Dr. Joseph Hyde Pratt, North Carolina State Geologist, read a paper: "Details of Arrangements for the Use of Convict Labor." This was discussed by C. M. Kerr, asst. engr. State Highway Dept., Louisiana; Dr. Frank Moore, Supt. State Reformatory, Rahway, N. J., and Col. Wm. Washington, N. Y. C. Following the conclusion of this discussion at the afternoon session the second general topic of the convention, Construction, was taken up, the first paper being "Determination of the Amount of Realignment, Grading and Drainage to be Done in Connection with Road Improvement," by S. D. Foster, ch. engr. of the Pennsylvania State Highway Dept. The

¹See Sept., 1913, issue, p. 136

discussion which followed was participated in by R. A. Mecker, New Jersey State Highway Engr.; Jas. H. MacDonald, former State Highway Engr. of Connecticut; J. A. Johnston, div. engr., Massachusetts Highway Commission, and Dr. Joseph Hyde Pratt. "Factors Governing a Proper Selection of Road or Street Pavement," a paper by L. R. Grabill, Supt. of Suburban Roads, Dist. of Columbia, discussed by Wm. D. Sohler, chmn. Massachusetts Highway Commission; W. A. McLean; R. B. Gage, chemist, New Jersey Dept. Public Roads, and D. B. Goodsell, asst. engr. Bur. Highways, Borough Manhattan, N. Y.

Third Day, Dec. 11—A series of papers on various types of construction was presented as follows: "Bituminous Macadam and Bituminous Concrete," Linn White, ch. engr. Board of South Park Commissioners, Chicago, read by Geo. L. Watson, N. Y. C., and discussed by Arthur H. Blanchard, Prof. Highway Engineering, Columbia University; "Earth Roads," E. A. Kingsley, State Highway Engr., Arkansas; "Sand-Clay Roads," which was the topic assigned to E. J. Watson, Commissioner of Agriculture, Commerce and Industries of South Carolina, was handled by Dr. Joseph Hyde Pratt; Major Crosby read the paper on "Gravel Roads," prepared by Geo. W. Cooley, State Engr., of Minnesota; the paper by F. F. Rogers, State Highway Commissioner of Michigan, "Concrete Roads" (published elsewhere in this issue) was read in Mr. Rogers's absence by Col. Wm. Washington; "Wood and Asphalt Block," by H. H. Schmidt, ch. engr., Bur. Highways, Brooklyn; "Water Bound Macadam," by Jos. W. Hunter, Deputy State Highway Commissioner of Pennsylvania; "Sheet Asphalt," by George H. Norton, Deputy Engr. Commissioner, Buffalo; "Granite Block," by R. H. Gillespie, Ch. Engr. of Highways, Borough of the Bronx, N. Y. C.; "Brick Roads," by J. M. McCleary, Road Engr., Cuyahoga Co., O., was on this session but was not presented.

Fourth Day, Dec. 12—The last day's session included a paper, "Unit Price and Lump Sum Contracts and Percentage Work," by H. C. Hill, discussed by several delegates; "The Testing of Materials for Roads and Street Construction," by Provost Hubbard, chemist in charge of the Division of Roads and Pavements of the Institute of Industrial Research, Washington, D. C.; and under the general subject of Maintenance, a paper by John N. Carlisle, State Highway Commissioner of N. Y., on "Sub-Organization for Securing

Efficient Maintenance"; "General Methods of Repairs and Renewals," by A. W. Dean, ch. engr., Massachusetts Highway Commission; "Bituminous Surface Treatment and Dust Prevention," by William H. Connell, Chief of Bur. of Highways and Street Cleaning of Philadelphia.

The third day of the convention there was an inspection tour of various roads and pavements in and near Philadelphia, participated in by 50 automobile loads of road men—this in spite of a cold, raw wind that made such inspection unpleasant.

The convention ended with the annual banquet of the association at the Bellevue-Stratford hotel.

The Omaha Cement Show, Jan. 30-31

Cement in every phase will have its inning at the Midwest Cement Show which will be held in Omaha in conjunction with the annual convention of the Nebraska Cement Users' Assn. Jan. 30-31 and Feb. 2-4, 1914. To use the words of Frank Whipperman, in charge of the show: "The object of this show shall be the promotion of a better knowledge of the proper use of cement; to advance its use as a building material, and to bring into closer relation all men interested in the cause." With 30% more space available through a rearrangement of the Auditorium, more than 70% of the space has been sold, with inquiries coming in daily.

The Nebraska Cement Users' Assn. will hold its annual convention in Omaha, at the time of the show, the convention opening Feb. 2 for a three-day session. Peter Palmer, Oakland, Neb., pres., has framed a program which includes many national authorities on cement and its uses. Sessions of the convention will be held in the morning only, thereby permitting the members to attend the show in the afternoon and the evening.

Program Nebraska Cement Users Assn., February 2-4

The program for the ninth annual convention of the Nebraska Cement Users' Assn., Convention Hall, Hotel Rome, Omaha, Feb. 2-4, in connection with the Mid-West Cement Exposition, Jan 30-Feb. 4, in the Auditorium is announced as follows:

Feb. 2—Formal Opening in Convention Hall, Hotel Rome; Address of Welcome by Mayor Dahlman, Omaha, and E. V. Parrish, manager Commercial Club, Omaha. "Concrete Foundation for Pavement," Geo. L. Campen, M. Am. Soc. C. E., Omaha. "Fundamental Material on Which the Concrete Industry Is Based," Alfred S. Johnson, editor *Cement World*, Chicago. "History of Concrete Plants in Omaha," T. G. Northwall, Omaha.

Feb. 3—"Reinforced Concrete," Albert C. Arend, B. S. C. E. Am. Soc. C. E., Omaha. "Concrete Roads," T. H. McDonald, Highway Engr., Ames, Ia. "Ornamental Concrete," B. Kevnild, Omaha.

Feb. 4—"How Concrete Meets the Farmer's Needs," A. J. R. Curtis, engr. Universal Portland Cement Co., Chicago. "Design and Layout of Concrete Product Plants," illustrated, E. S. Hanson, editor *Cement Era*, Chicago. Address by Ernest Ashton, chem. engr., Lehigh Portland Cement Co., Chicago. "Building a Man With a Concrete Backbone," Frank G. Odell, Omaha. "Development of the Cement Industry," Robert W. Hunt, Chicago.

Convention of Interstate Cement Tile Manufacturers' Assn.

The annual convention of the Interstate Cement Tile Mfrs. Assn. will be held in Chicago, Feb. 17, 18, and 19, 1914, while the Cement Show is on at the Coliseum. The sessions will be arranged so as not to conflict with the sessions of the Institute convention, and on the morning of Feb. 18, a joint session of the Am. Concrete Institute and the Interstate Cement Tile Mfrs. Assn. will be held.

At this joint session a paper will be presented by Rudolph J. Wig, of the U. S. Bur. of Standards, describing in detail the tests which that bureau is carrying on relative to the behavior of concrete tile in alkali soils. Tile used in the tests was made last summer at the plant of P. H. Atwood, Armstrong, Ia., pres. of the Tile Assn., and was laid in the fall. It has not, of course, been in service long enough to make available any data on its behavior, but Mr. Wig will present in his paper the general scope of the investigation, the method of manufacturing the pipe, and will give in detail the tests to which some of it was subjected at the plant where it was manufactured.

Dean A. Marston, of Ames, Ia., chmn. of Committee C 6, of the Am. Soc. for Test. Mat., will present a summary of the investigations and tests made by that committee. This committee, as is well known, has devoted a large amount of time to testing sewer pipe and drain tile with a view to establishing standards for these products.²

At this joint session, also, George P. Dieckmann, eh. chem. of the Northwestern States Port. Cem. Co., Mason City, Ia., will present the result of tests in reinforced concrete pipe which he has recently conducted.

One of the principal topics to be discussed in the sessions of the tile association will be that of concrete sewer pipe. This is a topic on which a large number of the members have been asking for information in the last year and it is planned to have the manufacturers of the various sewer pipe machines on the market present to explain the workings of their machines. These will not be in any sense mere trade talks, but will be purely technical descriptions of the workings of these machines, giving such details as members of the association are anxious to have. These and other papers will be illustrated with lantern slides.

Arthur P. Bent, Los Angeles, Cal., has been invited to be present at the convention and tell something of the work that his company is doing in having concrete pipe adopted for some very large contracts.

The convention will be held at the Auditorium hotel, Michigan Ave. and Congress St., Chicago, which will be the headquarters of the association, as well as the headquarters and meeting place of the American Concrete Institute and various others of the organizations which will meet at the time of the Cement Show.

As a result of the contest among 10 of the leading cities of the U. S. for the 1914 convention of the American Road Congress, under which title the American Highway Association and the American Automobile Association hold their annual conventions, Atlanta, Ga., has been selected as the next convention city. At the annual meeting of the directors of the American Highway Association which has just been held in Washington, D. C., the announcement was made that Atlanta had been selected by the Executive Committee of the Congress and that the convention would be held there beginning Oct. 19, 1914.

Tentative Program, National Conference on Concrete Road Building

If the tentative program of the National Conference on Concrete Road Building is an indication of the thoroughness of the work to be undertaken when this conference is in session at the Auditorium hotel, in Chicago, Feb. 12-14, 1914, it is certain to result in much good accomplished along the line of standardization. The tentative program follows:

THURS., FEB. 12, 9 A. M.

Reception and registration of delegates and visitors. Committee meetings.

First Session, 2 p. m.—W. F. M. Goss, Presiding; addresses as follows: "The National Conference on Concrete Road Building," W. F. M. Goss, dean, Coll. of Engrg., Univ. of Ill., Urbana, Ill.

"Financing Permanent Roads," S. E. Bradt, sec., Illinois State Highway Commission, Springfield, Ill.

"Can a Rural Community Afford Permanent Roads?" Oliver Dunlap, pres., Iowa State Supervisors Assn., chmn., Bd. of Supervisors, Washington Co., Ia.

"The Concrete Road System of Wayne Co., Mich.," Edward N. Hines, chmn., Bd. of Co. Road Commissioners, Wayne Co., Mich.

FRI., FEB. 13, 10 A. M.

Second Session—A. N. Johnson, presiding; "Development of Concrete Roads in the U. S.," Henry C. Shirley, ch. engr., Maryland State Roads Commission, Baltimore, Md.

Reports of Committees: I. Contraction and Expansion of Concrete Roads—Chairman, R. J. Wig, Bur. of Standards, Dept. of Com., Washington, D. C.; N. H. Tunncliffe, civ. engr., Davenport, Ia.; W. A. McIntyre, engr., Assn. of Am. Port. Cem. Mfrs., Philadelphia.

II. Joints for Concrete Roads—Chairman, W. K. Hatt, Prof. in Charge, School of Civ. Engrg., Purdue Univ., Lafayette, Ind.; George W. Cooley, State Engr., St. Paul, Minn.; R. J. Wig, Bur. of Standards, Dept. of Com., Washington, D. C.

III. Methods and Cost of Repairing and Maintaining Concrete Roads—Chairman, Edward N. Hines, Bd. of Co. Rd. Comm., Wayne Co., Detroit; J. S. McCullough, City Engr., Fond du Lac, Wis.; F. P. Wilson, City Engr., Mason City, Ia.

IV. Preparation and Treatment of Sub-Grade for Concrete Roads—Chairman, Ira O. Baker, Prof. of

Civ. Engrg., Univ. of Ill., Urbana, Ill.; A. R. Hirst, State Highway Engr., Madison, Wis.; A. N. Johnson, State Highway Engr., Springfield, Ill.

V. Reinforcement of Concrete Roads—Chairman, Thomas H. McDonald, State Highway Engr., Ames, Ia.; Henry E. Riggs, Prof. of Civ. Engrg., Univ. of Mich., Ann Arbor; Richard L. Humphrey, pres., Am. Concrete Inst., Philadelphia.

Third Session, 2 p. m.—Ira O. Baker, presiding; address, "Experiments with Concrete for Roads Conducted by the U. S. Office of Public Roads," Logan Waller Page, dir., U. S. Office of Public Roads, Washington.

Reports of Committees—VI. Aggregates for Concrete Roads—Chairman, Sanford E. Thompson, cons. engr., Newton Highlands, Mass.; A. N. Talbot, pres., Am. Soc. for Test. Mat., Urbana, Ill.; W. M. Kinney, asst. engr., Univ. Port. Cem. Co., Pittsburgh.

VII. Shoulders for Concrete Roads—Chairman, Maj. W. W. Crosby, Baltimore, Md.; C. A. Kingsley, State Highway Engr., Little Rock, Ark.; John H. Mullen, sec., Minn. Roadmakers Assn., St. Paul, Minn.; H. J. Kuelling, pres., Wis. Highway Commissioners' Assn., Milwaukee; E. D. Boyer, engr., Atlas Portland Cement Co., N. Y. C.

X. Economic Methods of Handling and Hauling Materials for Concrete Roads—Chairman, Halbert P. Gillette, editor, *Engineering & Contracting*, Chicago; Donald D. Price, state engr., Lincoln Neb.; Percy H. Wilson, sec., Assn. of Am. Port. Cem. Mfrs., Philadelphia.

SAT., FEB. 14, 2 P. M.

Fourth Session—W. F. M. Goss, presiding; address, "Concrete Road Construction by the Ohio State Highway Dept.," James R. Marker, State Highway Commissioner, Columbus, O.

Reports of Committees: XI. Mixing and Placing Materials for Concrete Roads—Chairman, Paul D. Sargent, ch. engr., State Highway Commission, Augusta, Me.; Arthur H. Blanchard, Prof. of Highway Engrg., Columbia Univ., N. Y. C.; C. W. Boynton, insp. engr., Univ. Port. Cem. Co., Chicago.

XII. Cost of Constructing Concrete Road—Chairman, A. N. Johnson, State Highway Engr., Springfield, Ill.; Joseph Hyde Pratt, State Engr., Chapel Hill, N. C.; Albert Reichman, pres., Western Soc. of Engrs., Chicago.

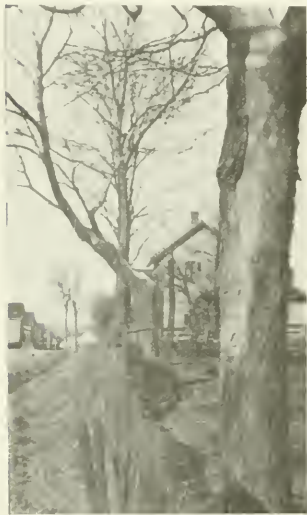
XIII. Thickness, Crown and Grades for Concrete Roads—Chairman, Leonard C. Smith, in charge of

²See p. 201 of Nov., 1913, issue

Roads and Pavements, Univ. of Wis., Madison, Wis.; Earle R. Whitmore, City Engr., Port Huron; T. R. Agg, Asst. Prof. in Civ. Engrg., Iowa State College, Ames, Ia.

XIV. Proportion and Consistency of Materials for Concrete Roads—Chairman, C. U. Bowley, City Engr., Sheboygan, Wis.; C. C. Widener, City Engr., Bozeman, Mont.; George A. Dingman, engr., Bd. of Co. Rd. Comm., Wayne Co., Detroit.

XV. Form of Specifications for Concrete Roads—Chairman, A. Marston, dean and dir., Div. of Engrg., Iowa State College, Ames, Ia.; A. N. Talbot, pres., Am. Soc. for Test. Mat., Urbana, Ill.; George W. Coolcy, State Engr., St. Paul, Minn.



A CAVITY IN A DECAYED TREE FILLED WITH CONCRETE

How Tree Dentistry is Practiced With Concrete

The accompanying illustration shows the way in which concrete can be used to stop decay in living trees. The dead wood at the edges of the wound was cut back as close as possible to the live bark and the cavity then cleaned of all dead and rotten wood. The cavity was next filled with a stiff 1:3 mixture, using Portland cement and sharp sand. A piece of 2-in. hexagon wire netting was placed in the center of the fill to reinforce it and prevent the concrete from sliding. Care was taken to make a tight and neat joint at the edges of the wound, so that the bark would have no difficulty in creeping on to the concrete. The concrete in the tree shown in the illustration was cast about 10" at a time.

New Books

Catskill Water Supply—Published by the Bd. of Water Supply, N. Y. C.; 31 pp., 9" x 6", paper, illus.

The Bd. of Water Supply, N. Y. C., is noted for the manner in which it has presented to the public all the details involved in the construction of the Catskill aqueduct. The booklet noted above brings the construction of this work down to date, reviewing the essential features and reproducing interesting photographs and drawings, making this great undertaking very clear.

The Concrete Bridge—Jno. B. Leonard and W. P. Day, San Francisco, 7" x 10½", paper, 40 pp., illus.

This is a most artistic and well prepared booklet which, as the authors state, is published to supply information on the vast strides made in California in the use of reinforced concrete for permanent bridge construction. The authors open the book with a brief, emphatic argument for the use of concrete, saying why it is the material in bridge construction. This is followed by a series of excellent photograph reproduction covering in detail many types of bridge construction.

The Manufacture of Lime—Technologic Paper No. 16, the Bur. of Standards—By Warren E. Emley, Asst. Chemist, Bur. of Standards, Washington, D. C., 10" x 1", paper, 130 pp. illus.

The object of this paper is to correlate and compare the equipments of various plants and processes with special reference to economy of operation and quality of the finished product. The paper includes a general discussion of lime, its manufacture and uses. Two or three typical plants distributed through the various lime-bearing deposits of the U. S. were visited. A general description and illustrations of the 19 plants are given in the appendix to this paper. The processes of manufacture of quicklime and of hydrated lime are discussed in detail and a discussion of heat utilization and efficiency is included.

Electrolysis of Concrete—Technologic paper No. 18, Bureau of Standards, Washington, D. C., by E. B. Rosa, Burton McCollum and O. S. Peters, 10" x 7", paper, 138 pp., illust.

Within the last few years attention has been called to the possibility of damage to reinforced concrete structures by stray currents from electric railways and other power sources. The laboratory experiments of Toch, Knudson and Langsdorf in 1906 and 1907 showed clearly that under certain conditions the passage of electric currents from the reinforcing material into the concrete gave rise not only to serious corrosion of the reinforcing material, but also to the cracking and splitting of the surrounding concrete. Since then numerous laboratory experiments have been carried out by various investigators, all tending to confirm the earlier observations in regard to the cracking of the concrete, but giving rise to various conflicting theories as to the cause of the phenomena observed. Following the earlier demonstrations of the possibility of damage to concrete by elec-

tric currents, reports of serious damage to certain concrete bridges and buildings became current and considerable apprehension has been aroused in some quarters that great damage may be in progress due to this cause. The subject was brought directly before the Bureau of Standards by letters of inquiry from engineers, contractors and corporations requesting information in regard to the probable extent of the damage and the most practicable method of preventing it. In order to place itself in a position to give such information to the public the Bureau has carried on an investigation consisting of three parts.

1. Laboratory investigation relating to the nature and cause of the phenomena produced by the passage of electric currents through concrete.

2. Investigations with the view to establishing the probable extent of the danger in practice and the circumstances under which trouble is most likely to occur.

3. A study of the various possible means of mitigating trouble from this source, leading to specific recommendations.

The results of these experiments are given in the paper listed above, in a comprehensive authentic report.

A preliminary report on this work was presented in a paper before the last convention of the Am. Concrete Institute, then the Natl. Assn. of Cement Users, Dec., 1912. This paper was published in *CONCRETE-CEMENT AGE*, Mar., 1913.

Hendricks's Commercial Register—S. E. Hendricks Co., New York. Twenty-second annual edition; 1,635 pp., 8" x 10½"; cloth, price \$10.00.

The new revised edition of *Hendricks's Commercial Register of the United States for Buyers and Sellers* has just been issued. Established in 1891, it has been published annually since that time. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. It covers the Architectural, Engineering, Electrical, Mechanical, Railroad, Mining, Manufacturing and kindred trades and professions. The 21st edition required 122 pages to index its contents, while the 22nd edition requires 138 pages, or 16 additional pages. As there are upwards of 400 classifications on each page, the 16 additional pages represent the manufacturers of over 6,000 articles, none of which has appeared in any previous edition. The total number of classifications in the book is over 55,000, each representing the manufacturers of or dealers in some machine, tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries.

The Science of Burning Liquid Fuel—William Newton Best, N. Y. C., 9½" x 6¼", cloth, 160 pp., illust.

This is a complete treatise, covering comprehensively materials and equipment needed in all classes of engineering. Many suggestions of value will be found.



A GRAVITY CHUTE CARRIED ON A SWINGING A-FRAME BOOM

Notes on the Erection of Boom-Supported Chutes for Conveying Concrete

The last few years have seen many developments in handling concrete by gravity and the following notes, from a letter recently received from the J. S. Wylie Co., Chicago, describe in detail how the frame and chute are erected. It is understood, of course, that this chute is received in the field knocked down. It is so furnished with field splices, however, that ordinary workmen can readily assemble the chute sections and the boom.

The first two sections of the chute, that is, the boom section and the first trussed section, are mounted together and are handled as a unit. The first operation in the correct method for setting this chute on the job is to mount the boom hinge brackets on long timbers. This forms a sliding frame which slides up and down the tower from one floor level to another as required.

This sliding frame is set up against the tower on the ground. Then the A-frame boom is placed in position and the hinge pins put in. The next operation should be that the lower trussed section is connected to the front end of the boom. Then the chute section is placed in position on top of the boom. The next and last operation is to place the receiving hopper in position on the sliding frame, connecting the lower part of the hopper into the boom chute section.

A topping line is made fast to the front end of the boom, passed

through a sheave or block directly over the center of the receiving hopper at the top of the tower. A block and fall is swung from the top of the tower, or some point higher than it is desired to place the chute for the first story concrete; attach this block and fall to the top member of the boom directly under the receiving hopper and all is ready to raise the chute into position. By taking hold of the block and fall line at the back of the boom and the topping line with the winch head of the hoisting engine (or these lines can be handled by men if an engine is not available) and raising on both lines at the same time the entire chute can be raised up the tower into position.

When the chute is at the height desired on the tower, the sliding frame is bolted to the tower with six bolts. When it is desired to move again for the next floor, hook up the line at the back of the boom again and hoist as before, bolting the sliding frame into the tower as before.

Before starting to raise the chute the trussed section should be swung around and lashed up to the bottom chord of the boom. Also the boom should hang straight out in front of the tower.

It is necessary that both the front and the back hoisting line be handled at the same time and at about the same speed so as to keep the boom in proper position and to keep it from

getting away from its position on the tower.

The whole apparatus, that is, the two sections described, together with the receiving hopper, sliding frame, etc., weighs only a little more than a ton and is therefore comparatively easy to hoist from one position to the next. An ordinary tower built of 4-in. x 6-in. timber such as is commonly used is quite suitable for this apparatus, as it does not require any special tower construction.

Orders for Extras on Construction Work

The proper handling of extras is always a big problem of construction work and contractors should require that all verbal instructions from the architect, engineer or owner, involving any change or addition to the plans and specifications, be confirmed in writing. All the attendant circumstances should be thoroughly understood.

The following paragraph, from some recent specifications for reinforced concrete work, is of interest in this connection:

EXTRA WORK: The contractor must be prepared to do any extra work that may be ordered in writing by the engineer, and for this he will be paid at current rates for work of a similar character, or if the extra work should be of a class for which no rate is fixed by current contracts, at the actual reasonable cost to the contractor, as determined by the engineer, plus 15% of said cost.

The contractor shall have no claim for compensation for extra work unless the same is ordered in writing by the engineer.¹

Arthur H. Blanchard, M. Am. Soc. C. E., consulting highway engineer and professor in charge of the graduate course in highway engineering at Columbia University, and Prevost Hubbard, Assoc. Am. Soc. C. E., consulting chemist, in charge of the division of roads and pavements, the Institute of Industrial Research of Washington, and lecturer in highway engineering chemistry in Columbia University, have formed a partnership under the firm name of Blanchard and Hubbard, highway efficiency experts, with offices at Broadway and 117th St., N. Y. C. At present Messrs. Blanchard and Hubbard are retained by Commissioner John H. Delaney, of the Advisory Board of Highways for the New York State Department of Efficiency and Economy.

¹The italics are ours.—EDITORS

New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

The Use of a Small Double Cone Batch Mixer

The small batch mixer is meeting a real need in turning out concrete at the point needed. Other pages of this issue show the construction of great snow sheds, where big capacity portable plants are used, and on the same job at the same time, a small batch mixer is working to good advantage. From the small builder to the big engineering contractor, all builders are recognizing the efficiency of the small mixer.

The accompanying illustrations show a 4-ft. mixer turned out by the T. L. Smith Co., Milwaukee. This mixer is essentially the standard

"Smith" mixer on a small scale, for the double cone principle is maintained.

In this little mixer, the "Mascot," the double cone churn, is carried in an annular ring and is driven and supported by two shafts carried on pedestals at either end of the machine. This central driving ring is completely enclosed by a dust-proof casing. This casing is kept full of grease and the pressure of the gears constantly forces this grease out between the two machined faces of the casing, thus preventing the entrance of dust by the outward pressure of the grease.

The sideloader is likewise a radical departure from the standard Smith



FIG. 2—THE SIDE LOADER OF THE SMALL SMITH MIXER



FIG. 1—THE SMITH 4-CU. FT. MIXER DISCHARGING CONCRETE

line, being a pivoted loader. The skip is mounted on a strong frame which includes the internal gear segment which is operated by a small pinion. As this small pinion travels on the segment, the skip is raised or lowered as the case may be. A strong clutch and brake complete the hoisting equipment, which is designed for simplicity and works easily and with great rapidity. The side loader weighs 650 lbs.

The water tank is carried on a frame above the mixer drum and discharges directly into the drum from the feed side.

The capacity of the mixer is 6 cu. ft. of unmixed material, that is, the sand, cement and stone before they are mixed, producing approximately 4 cu. ft. of mixed concrete. The machine requires 2 h. p.

Pneumatic Equipment for Placing Cement Mortar

Equipment for placing cement mortar by compressed air has received much attention from engineers and designers within the past few years. A machine designed for doing this work, known as the "Pactor," the invention of Wylie G. Wilson, is now being put on the market by the Parson Mfg. Co., N. Y. C. In this method the mortar materials are mixed with water before being placed in the machine. Hydration having been accomplished and the proportions duly fixed, the mortar in its wet condition is fed through the machine and blown along a hose by compressed air to the point of final placement.

GENERAL NOTES ON OPERATION

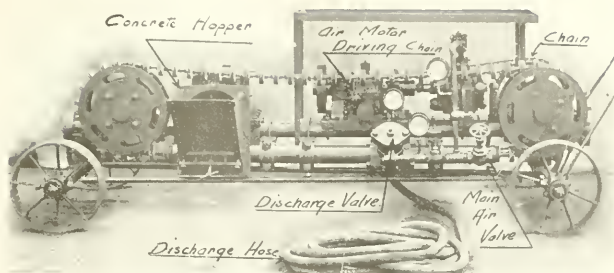
As the machine handles wet material, the hydration is fixed and remains stable, and is not subject to variation, providing the mixing is done with ordinary care and skill. As the mixing of mortars is an art so old and so well understood, uniformity to the extent requisite is practically always obtained.

As wet materials are used, there is no dust in operation nor is the cement in dry or partially hydrated condition blown away from the wall.

The machine has no valves. Its feed is continuous, and the discharge is also continuous. This is due to a very ingenious arrangement of the conveying means. Experience has shown that mixed mortar of any desired hydration proper for the work to be accomplished can be successfully handled.

The "Pactor" is pronounced by its makers to be incapable of being stopped in operation due to plugging of hose with the concrete materials. The only stoppages registered in a couple of years of work have been those caused by stone or other objects too large to pass through the hose. These are stated to have been easily removed in a few moments without impairing the machine in any way. Spikes and bolts have been dropped into the chain flights and these have also stalled the machine from time to time but have not done it any harm. So it is claimed that the machine is one which can be relied on for continuity of operation.

These are the main advantages claimed for the "Pactor." It is evident from the illustrations that there are other special advantages in operation in mines, tunnels or on other similar work. The machine is so low that wheelbarrows can readily be



A COMPRESSED AIR EQUIPMENT FOR PLACING CEMENT MORTAR

dumped into it and its operation can easily be overseen by a man standing alongside of it on the ground.

FIRST USE OF THIS EQUIPMENT

The "Pactor" was first used in connection with a very difficult job of repairing concrete girders and pillars at the warehouse and packing house of the Arbogast and Bastian Co., Allentown, Pa., where the concrete had been damaged by electrolysis. The method of operation was as follows: Water and sand were first used and were run through the "Pactor" to sand-blast the work and clean it ready for the placement of fresh concrete. The mortar materials were then mixed and put through the machine. The lower parts of a large number of girders varying in thickness from $1\frac{1}{2}$ " to 5" of new work were repaired by this agency with perfect success. The concrete thus replaced has shown itself to be fully as strong as, and probably stronger than, the materials of which these girders were originally composed. Weights were registered of approximately 146 lbs. per cu. ft. using a 1:3 mixture of cement and sand.

This equipment was then tried out on hydraulic work and gave an excellent account of itself throughout a long season under very adverse conditions. The machine, in the meantime, had been fully standardized and is now available on the following general specifications:

EQUIPMENT AVAILABLE

Capacity about 48 cu. ft. per hr. except where mortars very low in hydration are used.

Air required, approximately 200 cu. ft. per min.

Pressure, on air line:—70 lbs. to 80 lbs.; on the air discharge valve, from 20 lbs. to 55 lbs. depending on the work.

Length of hose capable of being used up to 200'—1" in internal diameter.

Pebbles of $1\frac{1}{2}$ " size or less will pass freely through the machine, but

it is expedient to limit them to $1\frac{1}{4}$ -in. size.

DETAIL NOTES ON OPERATION

The operation of the machine is briefly described as follows:

The mortar is mixed in the mortar box or in a small concrete mixer ($1\frac{1}{4}$ -yd. size being about right) and from there discharged directly into the hopper of the "Pactor." The quantity discharged by the "Pactor" will vary as the speed of the chain and this is controlled by a valve covering the motor which drives the machine (an air motor is used in most cases). In the hopper where the mortar is received there are fingers which agitate the materials and present them to the entrance of the containing tube, through which the chain passes. The pockets between the flights on the chain are filled with mortar and this advances through the tube until it passes across the face of the discharge valve. This valve is adjustable and is annular in shape. The effect produced is the steady supply of the body of concrete presented in succession to the various parts of the annular valve. After the concrete has blown away through the discharge port it is conducted along the hose and from there sprayed upon the work. The operative in charge at the nozzle has no valves or other apparatus to look after. His mind is thus concentrated upon the production of the stucco, plaster or other coating which the machine is furnishing.

If any of the materials are not blown away by the discharge valve, they are pulled along by the chain to the exit at the other end and there discharged into a receptacle placed to catch them, from which they are returned to the hopper and used over again.

If the machine is overfed, no harm results. The materials which the air blast cannot carry away are simply spilled out of the end and the materials which are carried away are, as to each particle, bathed in the re-

quired amount of air for the proper transportation thereof and the proper placement upon the structure as desired.

The theory of this operation is that each unit of material is, in a split of time, acted upon by a given quantity of air, and at a pressure sufficient to communicate an initial velocity to the material which has enough force, as to each particle thereof, to overcome the entire skin friction of the hose and then to place each successive particle upon the work. So well does this work out in practice that if the machine is stopped suddenly and the hose is disconnected, no material will be found in it.

The usefulness of an apparatus of this kind will suggest itself very readily but its manufacturers are sure that its best application can be made where the problems are of unusual difficulty and especially where the construction of concrete work with forms is attended with undue expense.

Expansion Joint for Pavement Work

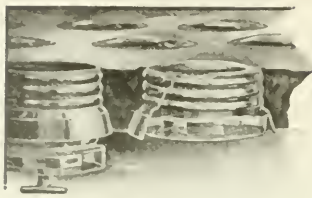
A new development in the expansion material field is the "B&B" expansion strip handled by Robert L. Beck, Cleveland. This strip is manufactured in 4-ft. lengths, with beveled ends, $1\frac{1}{2}"$ to $1\frac{1}{2}"$ in thickness, and 4" to 6" in depth as may be required. These strips are delivered to the job ready to use, and are laid parallel with the curb and between the curb and the pavement, in place of using wood strips and pouring hot material. They may also be placed between sections of the pavement, at a specified distance to allow for expansion and contraction.

The material consists essentially of asphalt, molded to the desired shape and size and having a flexible metallic reinforcing core, and oppositely beveled ends adapted to overlap the ends of adjacent strips.

Tests made by competent engineers show that this material will not melt under 180° F. and is elastic at 20° F. below zero, thus making a satisfactory expansion joint in winter and summer.

The use of this strip assures an expansion joint the full depth required. It is delivered to the job ready to lay and requires but one operation.

A patent has been issued covering the manufacture of this. It has been used successfully in Cleveland and its vicinity.



A SIDEWALK LIGHT WITH DETACHABLE GLASS INSERTS AND SCREW SOCKETS

A Detachable Sidewalk Light

The accompanying illustration shows a detachable sidewalk light of extremely simple design which has been invented by Sam C. Hanna, Los Angeles. When constructing the concrete sidewalk where there is a basement underneath to be lighted, a metal shell provided with threads is set in the concrete instead of the usual glass. Afterwards the glass, molded with threads to fit the shells, may be screwed into place with a socket wrench. Lights constructed in this way may be repaired very quickly at any time from underneath without damage to the walk.

Composition Roofing Instead of Tar and Gravel

Roofing conditions in the Southwest differ materially from those in the East. While there is no zero weather, snow or ice to contend with, there is present that which will cause disintegration of the roofing much more rapidly, namely, almost continuous sunshine.

A roof which has been in successful use in the Southwest is known as the "reinforced" roof, and is usually composed of two or three layers of asphalt saturated felt, laid shingle fashion, as in the gravel roof, and mopped between each layer as laid with asphalt and securely nailed to the roof sheathing. This surface is again heavily mopped with hot asphalt in which is embedded a layer of 2-ply ready roofing, lapped $2\frac{1}{4}"$, making a perfect bond between the asphalt felt and the roofing. No nails are used in this upper layer of ready roofing, eliminating that very objectionable feature.

The upper layer of roofing material has been coated with weather-resisting oils or compound in the process of making, so no mopping and graveling is necessary. This eliminates a useless weight of nearly 400 lbs. to the square. When it is necessary to renew the roof, another layer

of ready roofing is mopped down to the present surface and the roof is as good as when new. This is found an ideal roof and the manufacturers say that it is the lowest cost roof, per square per year, as there is no maintenance expense (no mopping or graveling), lighter construction (400 lbs. of gravel eliminated), and at renewal no heavy roof to remove and cart away,—and equally important,—should a leak occur it can be located immediately, which is rarely possible on an asphalt and gravel roof. It has been in general use for nearly 10 years and has satisfactorily withstood every test.

For concrete roof, mop the asphalt felt to the concrete roof in two moppings of hot asphalt, one put immediately on top of the other and secure a perfect bond between the roof slab and the felt. The Pioneer Paper Co., Los Angeles, makes a roofing material which has been extensively used in the above manner, and states that the cost of such a roof in the vicinity of Los Angeles is \$4.25 per 100 sq. ft. for the work applied. In San Francisco the same work costs about \$5.25.

Seven Rib Hy-Rib

Ribbed Steel mesh has in the last few years become a standard building material, and the Trussed Concrete Steel Co., Detroit, which developed "Hy-Rib," one of the first of these ribbed meshes, announces the manufacture of "Seven-Rib Hy-Rib" in larger sheets. "Seven-Rib Hy-Rib" comes in sheets 24" wide c. to c. of outside ribs. The ribs are $1\frac{1}{2}"$ high and 4" o. c. "Seven-Rib Hy-Rib" is made of 22-, 24-, 26-, or 28- ga. material. The standard lengths are 6', 8', 10' 12'. The material is shipped either painted or unpainted in bundles of eight sheets.

The Edison Concrete Products Co. has recently been organized for the manufacture of concrete specialties of various kinds. Thomas A. Edison is chairman of the board of directors. The main office is at 1133 Broadway, N. Y. C., with branch offices in Philadelphia and Boston. R. A. Paterson is vice-president and sales manager, with headquarters at the New York office. Mr. Paterson was formerly associated with the C. F. Massey Co., Chicago. The new company will devote its attention for the present largely to the manufacture of railroad specialties, such as culvert pipe, watchmen's houses and so on, and also other concrete products.

Concrete-Cement Age

Vol. IV.

February, 1914

No. 2

Houses That Are Homes

THE world over, housing commissions, corporations great and small, communities and individuals are interested in developing, for the rank and file, better housing facilities at the least cost. Concrete, in poured walls and floors, in light multiple units, in larger structural units, is the material in use everywhere. Truly, a new era of better, cleaner, permanent, fireproof homes is being ushered in. We are building, at last, real homes, not shacks, for our people, and concrete is the material used.

Bidding the Waves Be Still

A NEWS report comes to us that the International Bricklayers' and Stone Masons' Union of America has appropriated a quarter of a million dollars for an aggressive campaign against concrete. It seems to us, trying to view the matter impartially, that the money might be better spent in other ways. Concrete construction will stand or fall on its merits or demerits. Any antagonism originated by disturbed interests can have but a temporary effect, at the most. The money could be better spent in boosting than in "knocking," for "knocks" are boomerangs.

Getting Together

THIS year the great "get together" opportunity of the concrete industry will be from Feb. 12-21, and the opportunity is going to be an unusual one. The Cement Show which will be held in the Coliseum in Chicago during that time, undoubtedly will attract an unusually large attendance, because it is the only big annual exhibition of the year, and besides that, the conventions of the American Concrete Institute, Feb. 16-20, the Interstate Cement Tile Manufacturers' Association, Feb. 17-19, and the National Conference on Concrete Road Building, Feb. 12-14, will bring together men of the industry with a very wide range of interests. It should be worth a great deal to almost any man whose business of life is in the concrete field, to be in Chicago as much of the time from Feb. 12-21 as possible, and for those who are not intimately connected with the industry,

yet want to learn of its progress, will be afforded an unparalleled educational opportunity. Still others who are more or less connected with the concrete field will attend at this same time the meetings of the National Association of Sand and Gravel Producers, the National Builders' Supply Association, the Illinois Lumber Dealers' and Builders' Supply Association, and the Illinois Association of Municipal Contractors.

Concrete and Steel

REINFORCED concrete came out ahead in a recent strenuous structural competition in New York. Bids for the Austin-Nichols grocery warehouse, the largest in the world, ran too high. Cass Gilbert, the architect, of Woolworth building fame, put it right up to the designing and estimating engineers of a score of the country's largest firms of contractors to submit plans and estimates for a structure to meet certain definite requirements of strength, permanence, fireproofness, etc. It was a battle royal between structural steel frame, fireproofed with concrete or tile, and straight reinforced concrete construction. Reinforced concrete won, hands down. Construction is under way.

Putting Concrete Buildings on the Map

IT doesn't take a very old timer in concrete work to remember the time when every reinforced concrete building meant the hardest kind of a fight to convince the owner and the architect that reinforced concrete was a safe building material to use. We remember especially the situation almost a decade ago in one of our middle western cities, which is well up in the list of our 10 largest, where the public school buildings were designed for steel frame, cinder-fireproofed. By the greatest kind of hard work, the companies doing reinforced concrete work had a clause inserted in the school specifications allowing for alternate figures on reinforced concrete beams, girders and columns, to replace the structural steel. Things went along, apparently swimmingly, until the day the figures were going in on a big High school building, when it was found necessary to get the various steel companies to submit a figure on some of the structural steel work, such as window lintels, column bases and

miscellaneous iron work. The structural steel companies, who were presenting a solid front against the aggressions of reinforced concrete, absolutely refused to "split" their figures and give out a figure on the steel work required, outside of the columns, beams, and girders, so that at the last minute the concrete companies were thus unable to submit an intelligent figure.

The architect of the Board of Education was an open-minded man and ready to be shown the value of reinforced concrete for construction; the next step was the insertion of a clause requiring the structural steel companies to submit their figures in two ways; one for all the structural steel, including lintels, accessories, etc., and the other figure for all the steel required except the floor beams, girders and columns. After an extended and aggressive educational campaign with the building committee of the Board of Education a contract was finally awarded for a school building of reinforced concrete floor and column construction. This was hailed as a victory, for it meant that the way was open for reinforced concrete.

In the light of an article in this issue describing how reinforced concrete has made such wonderful advances in the New York territory, it is interesting to "reminisce" a little on the fight that has been made to establish reinforced concrete as a standard building material. From one coast to another the fight now is practically won, and our efforts must be directed toward standardizing reinforced concrete, and toward practice which will absolutely eliminate failures, and make every concrete building a satisfactory structure, satisfactory to the owner, the architect and the builder.

To Architects

AN article in this issue which tells something about the production of ornamental concrete work at the School of Industrial Art in Philadelphia should help to show those who are in a position to specify ornamental products of this kind that concrete has distinct and characteristic beauties which can be made use of on a great many works. Knowing that such things are possible with concrete, architects and others have only to ask for them.

Concrete Road Maintenance

THOUSANDS of road-builders have inspected the concrete roads which have been built in Wayne County, Mich., in the last five years. Probably more has been printed about and more said about these roads than about any other like work in road construction. The work of Wayne county has undoubtedly had a greater influence upon the present trend of road building than any other single experiment in road construction which has ever been tried. And because of the interest aroused and the influence which Wayne County's work has had, the Wayne County work has been minutely examined for flaws.

When the word "permanent" is applied to any kind of road or pavement, it is of course used rather loosely. It is used relatively. This magazine has so used it, because everybody knows that in the last analysis the word permanent applies to nothing which is material. Wayne County first tried other types of road construction. Some of them were very cheap on a basis of first cost only, and that they are cheap in first cost only was quickly discovered, because the main highways of the county are continuations of the main thoroughfares of the city of Detroit and stand a hard mixed traffic. Concrete was tried and year after year the quality of the concrete and the methods employed in laying have, it is believed, been greatly improved. Yet in spite of the splendid results which Wayne County shows, it is only natural that road-builders everywhere should ask one more question: How much does it cost to maintain these roads? That question could not be answered immediately. The small amount spent when a concrete road was one year old could not form a satisfactory basis for judgment. Yet now, when the earliest of the Wayne County concrete roads has been in use more than four years; when a still greater quantity has been in use more than three years and yet a greater quantity for more than two years and so on, the opportunity has presented itself for a study of maintenance costs. We consider, therefore, that much importance attaches to the authoritative information published elsewhere in this issue on maintenance methods and costs on these roads for the year 1913.

Construction Efficiency

TO get concrete up on a building a well built tower is erected. The workmen often have to scramble up and down shaky, unprotected ladders. To get from the bottom to the top, or vice versa, is quite a job. It takes time and effort, both of which have a definite money value.

In building a great standpipe at Fulton, N. Y., the engineer in charge of the work built the construction tower approximately twice the size of the concrete, and one-half the tower was given over to a well-built enclosed stairway. This stairway furnished easy, rapid, and safe communication between the top and the bottom of the work at all times, and, while costing rather heavily at first, it made for construction efficiency. It paid.

Form Builders and Carpenters

In the Oct., 1913, issue was discussed editorially the question of whether or not concrete form builders should be considered as carpenters. We pointed out in particular the danger of determining the status of form builders, not according to the principles of law laid down by an Appellate Court but by resolutions of labor unions and other organizations. In this connection, Geo. Simpson, of the firm of G. Simpson & Co., contractors, Dunedin, New Zealand, who saw the comment in our October issue, has sent us a clipping from the *Otago Daily Times* of Dunedin, N. Z. The clipping is a report of a decision in the Arbitration Court and is as follows:

ARBITRATION COURT

Wellington, N. Z., Nov. 13, 1913.

The Arbitration Court decided an appeal lodged by the Inspector of Awards against the decision of a magistrate who held that *the making of boxing for concrete work was not carpenter's work and could be done by an ordinary laborer.*¹ This decision was upheld.

There is no excuse for using dirty concrete aggregate. From the use of a garden hose over wheelbarrows with perforated bottoms, to great power washing plants, there is material washing equipment to meet every need.

¹The italics are ours—EDITORS

The Use of Concrete in the Construction of a Water Garden

BY ERNEST F. COE¹

Such effects as we frequently see produced by the beautiful water gardens in parks and other public places are commonly considered out of the question in drawing up one's own home garden plans, yet rock and water gardens are quite possible on a small or a large scale as space permits, with no more water necessary than is used to keep an ordinary city lawn in good condition—providing concrete is used to keep the water from getting away. The rock and water garden shown in the accompanying illustrations is in a space of about 100' x 150' only, and this particular work includes half a dozen pools and several runways connecting them. Mr. Coe describes just how the work was done, so that no one need fear to attempt it if he has any ingenuity at all in this direction.

The introduction of water effects in garden-making often adds a most pleasing feature, and the accompanying illustrations show some work which would have been quite impossible without the liberal use of reinforced concrete.

In this special instance it was desired to create a naturalistic, brook-like effect down through a section of the lawn where no water existed, but where the general slopes were such as to make the introduction of a brook effective and consistent. The only available water was the city supply, to be paid for at meter rates. So any undue loss of this precious liquid was to be avoided so far as possible. Any construction which was to be reasonably economical under such circumstances must be sufficiently tight to prevent seepage, yet the soil itself was too loose to retain water.



FIG. 1—A REINFORCED CONCRETE ARCH BRIDGE—ON A SMALL SCALE

A plan was adopted to create a series of pools terminating in a pond. There was a drop in grade of about 9 ft. between the first pool and the end pond. This was taken advantage of in the design, so that aside from the gentle drop of the grade at the runways between the pools it was possible to make quite a little waterfall between the fifth and the sixth pool, which added much to the attractiveness of the general final effect. This is seen in Fig. 2. The main practical problems involved so far as the concrete construction was concerned were first to make the whole system watertight, and this was easily done by

using a liberal amount of concrete and, second, to construct the basins so that they would not be injured by winter freezing, for the frosts in this section occasionally penetrate the earth 4' to 5'. To accomplish this we used heavy wire netting freely between the first and the second courses of concrete as described later. A third problem was to break joints so as to accommodate contraction and expansion due to frost and other causes between pools and runways. This we worked out successfully by first casting the runways between the pools. After these were firmly set, the intervening pools were made. By

this method we succeeded in creating a joint at either end of each pool which was calculated to accommodate both contraction and expansion without serious injury to the structure as a whole. Each pool is a unit and as firm as an oyster shell. Further, by making the pools quite shelving, any danger from expansion in the event that they should freeze solid has been overcome as the ice would have a tendency to slip upward and relieve any pressure.



FIG. 2—A WATERFALL FROM ONE CONCRETE RUNWAY TO ANOTHER, WITH NO MORE WATER THAN IS SUPPLIED BY GARDEN HOSE

¹Landscape Arch., New Haven, Conn.



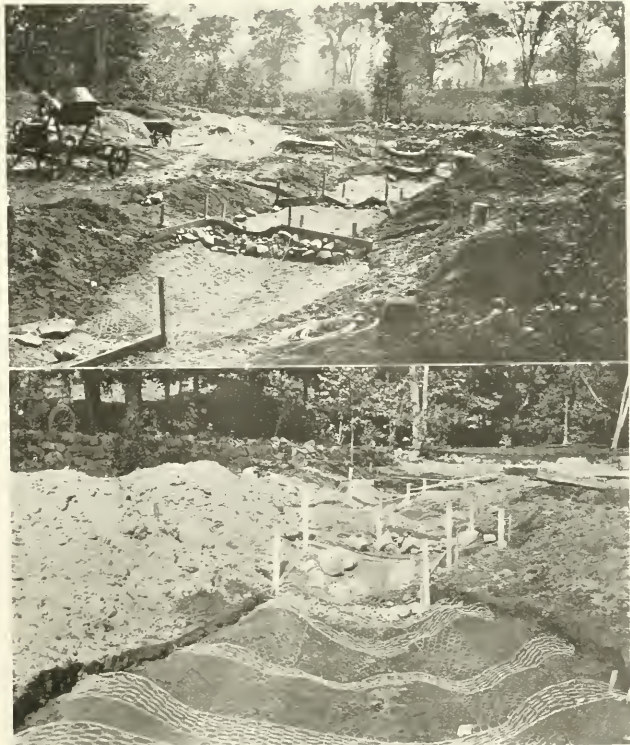
FIG. 3—IT'S ALL NATURAL ENOUGH—EXCEPT THAT THE WATER SUPPLY CAME THROUGH A SMALL PIPE

FIG. 4—THE LAST ONE IN THE CHAIN OF ARTIFICIAL POOLS



FIG. 5—CONCRETE MADE IT POSSIBLE BUT IS NOT IN EVIDENCE. HOW NATURE FINISHED MAN'S WORK IN LESS THAN THREE MONTHS

The concrete was made of a good grade of cement and clean sand, and crushed trap rock, proportioned 1:2:3, mixed wet. After thoroughly mixing, the first course was poured about 4 in. thick over the earth floor of the excavations. This was firmly but not very thoroughly tamped. A heavy grade of wire poultry netting about 1 ft. wide was then spread lengthwise and crosswise over each pool and several times around, holding this wire temporarily in place by heavy stones and boulders. Another 4" to 6" of a similar mixture of concrete was then placed over the wire and the whole mass firmly and very thoroughly tamped, giving each pool its final shape and with care to maintain grades. Before this second pouring had set thoroughly, a thin grout of 1 part cement to 1 part sand was poured over the surfaces and thoroughly brushed in with a coarse stable broom, the idea being that this surface grout would have a tendency to work its way in and fill up any voids. No waterproofing was employed, though it might have been a good precaution. After the concrete part of this work had been completed the general effect was quite unsightly, and it would be hard to imagine how attractive the work would finally appear. The concrete in this instance, however, was used for foundation purposes only, with the intention of quite covering it up when the work was completed.



FIGS. 6 AND 7—THE RUNWAYS UNDER CONSTRUCTION



FIG. 8—A CONCRETE FLAT SLAB BRIDGE—FOR FOOT TRAFFIC ONLY

Mossy stones and boulders of various sizes were later placed about the margins of the brooks and pond, filling in with soil and plantings. Water lilies and bog plants were placed in suitable locations. Mosses and other brookside vegetation were brought in from neighboring streams and within the short time of 10 weeks the beautiful effects shown by the accompanying illustrations were created.

EDITORIAL DISCUSSION

One thing which is quite noticeable in Mr. Coe's work which is here illustrated is the fact that concrete, while a most useful material and in



FIG. 9—SUGGESTED CROSS-SECTION FOR CONCRETE POOLS SO THAT MARGINS MAY BE CONCEALED

fact essential in this case, is nowhere in evidence.

If the effect is to be as natural as possible, concrete must be kept out of sight. The accompanying sketch, Fig. 9, may serve to give an idea of how this is to be done. It will be noticed in Fig. 7 that the concrete tips downward at the edges. This was afterwards covered with earth so that there are no edges of concrete to be seen. Another way (as shown in Fig. 9) to make sure that the concrete won't show and yet have the concrete come above the point at the edge of the pool where the water level is wanted, is to make a slight ridge around the inside of the pool so that the top of the ridge which should be, say 3" high, will be a little below the water level, or, in the construction, a little below the outer edge of the concrete basin. This

ridge will make it possible to extend earth and sod over the edge of the concrete, or to place stones or gravel along the rim without their being so easily washed off. The water level in the sketch is indicated by the dotted line.

In Fig. 1 is seen a reinforced concrete arch bridge, yet the concrete is all out of sight, and in Fig. 8 is seen a concrete slab extending from one of the streams connecting the pools. Figs. 6 and 7 give an excellent idea of the way the work was laid out with grades determined between the runways and pools, and they also give an idea of how the chicken wire mesh was placed, in 1-ft. widths.

Mr. Coe does not mention the depth of these pools, but a depth of 2' in the center is plenty for almost all of the lilies and water plants which one would care to grow, and so far as a limited supply of water is concerned, it should perhaps be added that the water plants generally considered most beautiful will not grow where there is a steady inflow of fresh water. They do best in still water and a proper balance of plant growth and fish life in such pools keeps the water in good condition, and the fish may be depended upon to take care of the mosquito problem. As an aid to the maintenance of pure, sweet water, some oxygenating plants should be used.

Methods Employed in Wrecking Concrete Buildings

In America, housing conditions demand change so often and so rapidly that some objections have been brought against concrete on the grounds that it is too permanent a material. In the few cases in which it has been necessary to wreck a con-

crete building, however, the ingenuity of the contractor has developed methods and means which made the demolition an unusual, though not an extraordinarily hard problem. Of interest in this connection is a book recently published by Wm. Ernst & Son, Berlin, entitled "The Demolition of Concrete and Reinforced Concrete Buildings." The author is Ernst Schick.

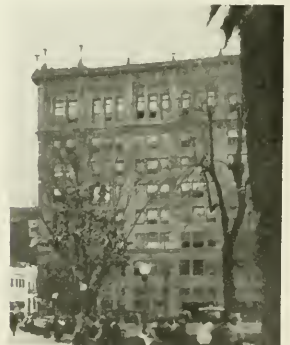
As the author states in opening chapters, theoretical treatment of the problem is impossible and practical data so far available are very meager. The author outlines the problem in general, and describes many specific instances in which concrete structures have been wrecked.

In breaking up the general run of concrete work the author states that experience has shown that pneumatic tools present a certain advantage over hand tools, and if any considerable work is in hand the cost of the equipment is quickly paid for. Large masses of concrete are broken up by explosives. In some places drop weights have been used. The steel reinforcement is usually cut with an oxy-acetylene flame.

Concrete Electroliers Form Part of Architect's Design

A new concrete office building in Los Angeles has secured a very pleasing effect in its design by combining electroliers as a part of the architectural plan. These are of concrete and rise from the cornice of the building to about 10 ft. in height. They terminate in five lights which form a cross.

These electroliers, which extend around the building, give a dignified touch to it in the day time as well as at night, when the lights are turned on.



CONCRETE ELECTROLIERS AROUND THE CORNICE OF A MODERN CITY BUILDING

Field Notes on the Construction of a Great Concrete Standpipe

By ALLEN D. WHIPPLE¹

In the Dec., 1913, issue, we were able to publish an outline description of the construction of a reinforced concrete standpipe at Fulton, N. Y. This standpipe was of especial interest because the cylinder, or the standpipe proper, rests on a slip joint, entirely disconnected from the base. The engineering features of this work were covered in detail in the article in the issue referred to.

The following notes, written by Mr. Whipple, at our request, have come in a letter, giving a comprehensive view of the problem of the work from the viewpoint of the contractor. To preserve and bring to our readers the spirit in which this was written, the letter-form has been retained. The notes are frank, and to the point. It is a message from the field, as though the Heart of the Work had spoken.

To build a tube of the gigantic proportions of the standpipe at Fulton, N. Y., namely, 40' inside diameter by 100' in height, is in itself a notable undertaking, but when there is added to the general problem the production of a seamless tube, or one in which there shall be no appreciable setting of the concrete at any point before the next successive layer has been added to its height, the problem becomes not doubly difficult, but one in which the difficulties are increased in geometrical proportion. If, now, we add to this the desire to produce walls which shall be waterproof without the use of any means for securing this result other than the somewhat liberal use of Portland cement, and technical care in grading the aggregate, the difficulties are still more increased. Again, let us add to all the above the fact that the work could not be commenced until Oct. 1, and must be completed the same season, and, too, that it is located in northern New York state where the winters are severe, and altogether, we have an undertaking which should not be attempted with-



FIG. 1—STARTING THE FOUNDATION WORK, OCT. 17, 1913

This shows the steel in place for the foundation, the combined inlet and outlet pipe, concrete plant, cement shed, etc.

out previous exact knowledge of its intricacies, and an equipment particularly designed and assembled for the work in hand.

It may not, at first glance, have been apparent to many that the suc-

cessful construction of a standpipe, the wall of which is free from the base and can therefore expand or contract freely under the influence of temperature stresses or of those due to varying water pressure, demon-



FIG. 2—THE FOUNDATION ON THE FULTON STANDPIPE COMPLETED, OCT. 21, 1913

At the right, sand is being placed to cure the concrete properly. At the left, the raised portions of the base can be seen. This view is taken from a point about where the men are standing to the left of Fig. 1

¹Const. Engr., A. Mönsted Co., Milwaukee



FIG. 3—PLACING THE GRAPHITE AND SHEET COPPER SLIP JOINT, OCT. 22, 1913

At the left may be seen the wooden rings for the interior form. The cross-pieces for supporting these are the segmental combination wood and plaster molds used as forms for the raised portion of the base; they may be clearly seen below the wooden rings

strates a theory which makes possible the production of standpipes in concrete of better quality and of more economical design than has heretofore been the practice.

Right here I wish to express our appreciation of the co-operation in this unusual work by William Mueser of the Concrete-Steel Engrg. Co., N. Y. C., the designer, and this was

of great importance in the successful outcome of the undertaking.

Credit should also be given to Chas. F. Bornefeld and E. H. Harder, res. engrs. for the Concrete-Steel Engrg. Co., in charge of the work at Fulton, for their care and co-operation in the work. One of them was present days and the other nights for the entire time consumed in the pouring of the shell.

HANDLING THE CENTERING

Two methods of handling the falsework were permitted under the specifications. If seamless work was to be realized, the method of building two or more sets of forms designed to be set up one on top of the other and filled successively could not be considered. The time which would necessarily elapse between the filling of one set of forms and the next would be several hours under the best of conditions, and the setting process of the cement would have progressed so far that a bonded joint would have been required at each setting. While it is not certain that these planes of separation would have leaked, it is our opinion that, with the class of labor available, there would have been great probability of such leakage. As the stresses ordinarily set up in such walls tend to produce horizontal cracks, the presence of these bonded planes would be an element of worry and danger and might even negate the demonstration of the theory involved.

Something like the foregoing consideration led us to believe that the system of gradually and continuous-

ly sliding the falsework up the comparatively green wall, keeping the forms continually filled with fresh concrete, was the ideal method to adopt. This was accordingly done. The movement of the forms was so slow and gradual that an onlooker would not have readily noticed that the forms were moving at all; still they averaged a vertical movement of 5' per day.

How the above was accomplished is perhaps best illustrated by the



FIG. 5—A DETAIL OF THE RADIAL TRUSS

This shows the arrangement of the radial timbers and the truss rods

photographs, a few of which I shall use in trying to explain the procedure.

THE START

The excavation disclosed a gravel bed underlaid with a fine sand, which was slightly cemented, that is, just sufficiently to stand up in the bank, as shown in Fig. 1. Although the surface of this sand bed stood at a considerable angle, a careful consideration of the surrounding conditions and the character of the bed itself convinced all parties that a practically uniform and satisfactory bearing had been found at the level shown, which was somewhat deeper than originally intended. Fig. 1 gives a good idea of the shape of the foundation steel in place, as well as the combined inlet and outlet pipe. No outside forms were used for the foundation, except the small piece shown where the pipe emerges. The concrete was cast directly in contact with the bank, with the desire of preventing any artificial drainage surface around the foundation.

LIGHTING FOR NIGHT WORK

Electric lights were installed to furnish light for the night work and proved to be quite satisfactory, dis-



FIG. 4—ASSEMBLING THE RADIAL TRUSS FOR THE INSIDE FORM, AN "AEROPLANE" VIEW
The photograph for this view was taken Oct. 26, 1913

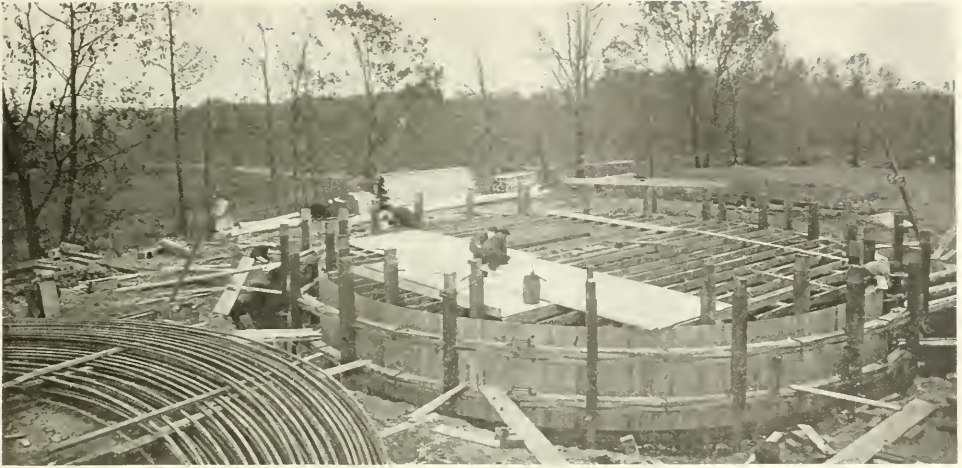


Fig. 6—A GENERAL VIEW OF THE PROGRESS OF THE WORK, A REPRODUCTION OF A PHOTOGRAPH MADE OCT. 29, 1913

The platform is being decked over, and the radial truss for the interior form is complete. The ribs for the exterior form are in place, and the yokes are ready for the head piece. This view shows the electric lights and the reinforcing steel, bent ready for placing

posed in clusters on poles, one group on the post, over the inlet pipe, another at the corner of the cement shed and another at the corner of the office building in the middle distance, and in other locations not shown in this view. Carbon filament lamps were used where they were apt to be subjected to rough treatment or excessive vibration and tungsten lamps were used for the more solid and protected positions.

The concrete was deposited through spouts, suspended from a cable attached to the tower at one end and made fast to a convenient tree at the other; the upper spout was open, being shaped like the letter "U" and provided with angles at the upper edges to act as stiffeners. This arrangement served to convey practically all of the concrete used on the entire job, the cable and spout being raised up the tower as the job progressed.

ORDERING MATERIAL EARLY

I have previously mentioned the approaching cold weather. In order to guard against any possible delay on account of the non-arrival of material, and being favored with plenty of storage space, we placed orders for all materials directly after signing the contract and urged immediate delivery.

MATERIALS USED

The same illustration (Fig. 1) shows, protruding beyond the cement shed at both ends, the pile of crushed stone sufficient for the entire job, which was piled up while the equipment was being set up. The end of

the sand pile can be seen at the right margin of the view, beyond the hoisting engine. The entire steel for the job was on the ground and bent at the time this photograph for Fig. 1 was taken. The crushed stone was purchased, after careful inspection of available supplies, from the Rock Cut Stone Co., Syracuse, N. Y., and was shipped to Fulton via N. Y. Central Ry. and teamed a distance of

about 1 mi. The sand was purchased locally, delivered by team to the job, while the cement was ordered from the Universal Portland Cement Co. The reinforcing steel, consisting of "Diamond" bars, came from Jones and Laughlin, Pittsburgh. Some of the large timbers were purchased from Syracuse, but most of the lumber came from Henderson & Thomson Co., Fulton. Necessary hardware



Fig. 7—THE COMPLETED FORMS SHORTLY AFTER THEY HAD BEGUN TO MOVE

This is a reproduction of a view taken Nov. 5, 1913. It is evident that the forms have moved upward about 8 ins. This view shows, too, the assemblage of horizontal rods with vertical detail



FIG. 8—THE PROGRESS OF THE WORK NOV. 7, 1913

This shows, in the lower right hand corner, the mixing plant. The enclosed stairway in the tower is shown plainly, as is also the suspended scaffold for rubbing down the outside of the structure

was purchased from the L. P. Smith Co., Fulton, and from Burhans and Black, Syracuse. The special machine work for the tension hub of the radial truss, described later, was done by Dilts Mach. Works, Fulton, to whom we are indebted for never-failing courtesy and assistance. The structural ladder which gives access to the top of the completed structure

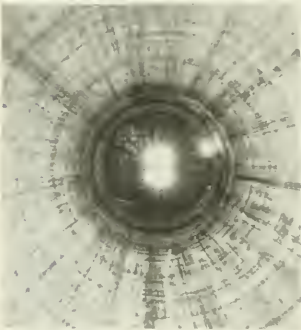


FIG. 9—THE PRACTICALLY COMPLETED STANDPIPE AT FULTON, LOOKING UP THE INSIDE OF THE SHAFT

was furnished by Thelen Bros., Syracuse. The special sawing of the plank to given radii for the construction of the circular ribs of the movable forms for the shell, as well as the special lagging used, was furnished by the Markert Mfg. Co., Syracuse. The sheet copper work comprising a part of the slip joint at the base of the wall was furnished by Cashman & McCarthy, Syracuse. It will be noted that the majority of the supplies had to be shipped in and teamed.

I have mentioned the foregoing long list for four distinct reasons:

First, to give proper credit to those who assisted us in this work, some of whom went to extraordinary pains to see that their materials were promptly on hand;

Second, to show that even though such a structure be erected in one of the smaller cities, where supplies are not readily available, and there is urgent need for speed, no apprehension need be felt by the contractor if he will use due precaution in getting all details in hand and order supplies at once and see to it that deliveries are promptly made;

Third, to show that there is considerable detail involved in such work besides mixing and depositing concrete;

Fourth, to emphasize the fact that the contractor who wishes to attempt this class of structures must be financially equipped to buy all his materials and get them on the ground



FIG. 10—DEC. 5, 1913, THE CENTERING PRACTICALLY COMPLETE FOR THE DOME

This is the same sheathing material used for the platform in Fig. 6



FIG. 11—DEC. 29, 1913, THE DOME COMPLETE

without having to depend upon the periodical payments which may at times be delayed. Once this work is started, it must not stop for any cause.

THE FOUNDATION COMPLETED

Fig. 2 shows the appearance of the

completed foundation Oct. 21, 1913. Upon this at the time we were spreading moist sand to protect the floor from crazing or damage, as this floor is expected to be watertight un-

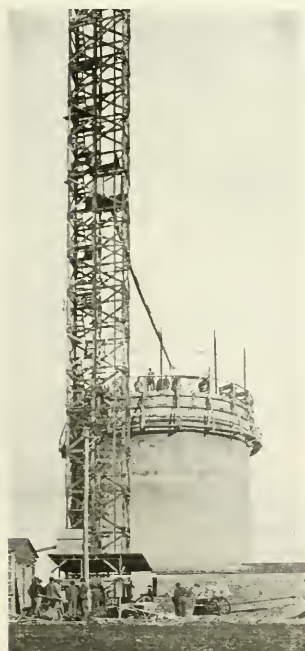


FIG. 12—NOV. 14, 1913, "GOING UP" WITH THE FULTON STANDPIPE

February, 1914

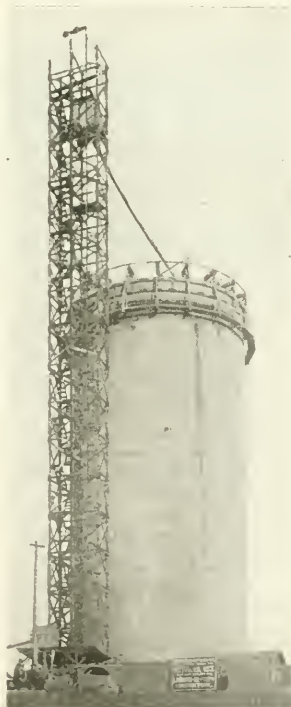


FIG. 13—NOV. 25, 1913, THE 100-FT. LEVEL ON THE FULTON STANDPIPE

der a water pressure of 6,250 lbs. per sq. ft. The bell of the inlet pipe shows clearly in this illustration, as well as the 8-in. elevation of the center of the foundation, above the rim, to provide one wall of the "V" slot shown in the illustration in the Dec., 1913, issue.² The other wall of the "V" slot was formed by the shell itself. The white appearance on the sand and ground is caused by the first snow of the season.

THE PLANT USED; THE STAIRWAY TOWER

The plant used was as follows: An erecting tower of timber was built as a first operation to a height of 164' in order that there should be no necessity of handling timber over the heads of concrete laborers working at the base of the tower. We call particular attention to this tower. It is 6' x 12' in plan and is provided with a complete stairway within the structure from bottom to top, for the use of the oiler who cares for the running gear at the top of the hoist, for the use of the man at the hopper who regulates the flow of concrete in the chutes and for all laborers engaged on the tank in going to and from their work. We may be considered eccentric in building so expensive a tower, but experience has proven that it is economy in the long run. The time saved by the men in going to and from their work repays the extra cost, not to mention the in-

²This refers to Fig. 2, p. 281

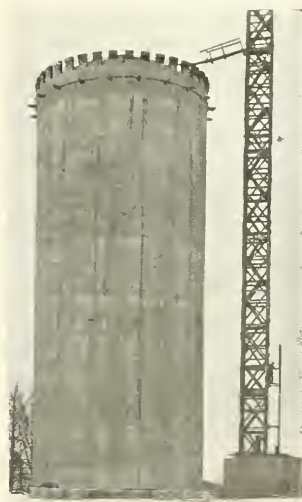


FIG. 14—DEC. 29, 1913, THE COMPLETED REINFORCED CONCRETE STANDPIPE AT FULTON, N. Y., FILLED TO A DEPTH OF 96'

creased rigidity of the tower, and, greatest of all, the prevention of accidents.

SAFETY PRECAUTIONS FOR WORKMEN

This matter of the prevention of accidents is of the highest importance, for it must be remembered that where labor is picked up locally, one cannot select men who are trained to work safely at great altitudes. They simply are not available. We doubt also that men can ever be said to be safe when working at great distances from the ground, unless special means be taken to safeguard them. A sudden fit of dizziness, a mis-step or the acts of a fellow workman may precipitate them to their death without warning unless the employer has carefully provided in his equipment for the prevention of such accidents. Our company has given this point so much attention and has achieved such great success in the prevention of accidents, that the Wisconsin State Industrial Commission, in a recently created committee, included the writer as a member to secure information and report upon ways and means for the prevention of personal injury to those engaged in the building trades in general in Wisconsin. Any CONCRETE-CEMENT AGE readers who may feel so inclined will confer a favor if they will communicate with the writer as to any methods or devices which experience has taught them to be effective in preventing accidents in building work. We want to call attention in all these illustrations to the complete absence of unclinchd nails in blocks of wood lying about, upon which a workman might inadvertently step.

FURTHER NOTE ON PLANT

The plant further consists of a Smith concrete bucket hoist,¹ the rails of which are mounted outside the tower on the side opposite or furthest removed from the standpipe. This bucket was raised by a "single lead" cable in conjunction with a Lidgerwood² hoisting engine, as shown in Fig. 1. An additional 30-h.p. boiler was installed near the hoisting engine to furnish steam for heating water and such other purposes as might be required.

The mixer selected for this job was a Smith³ "No. 104 Mascot" somewhat larger than a watch charm, at first glance only a working model of a mixer.⁴ I want to say right here that it performed all the work required of it fully up to our expectations, and we feel very friendly towards that little machine.

SMALL BATCHES NECESSARY

It must be remembered that the total yardage of the shell for this standpipe is very small, approximately $7\frac{1}{2}$ cu. yds. per ft. of height, and, as the writer is particularly insistent that concrete be not allowed to remain over five min. in a revolving mixer, after the water is added, a very small per batch capacity is indicated, for the reason that possible accidental or unexpected difficulties in handling steel, etc., may make it impossible to receive a large batch immediately, while a small one can almost always be accommodated in the wall. This obviates the necessity of holding the batch in the revolving mixer, or worse yet, depositing it in the bucket or hopper during an enforced wait. In other words, my desire was to produce, as nearly as possible with a batch mixer, a continuous flow of freshly mixed concrete, comparable in volume to the yardage put in during 24 hrs. continuous operation.

The machine was driven by a gasoline engine, mounted on the same truck. This machine is shown at the base of the tower in the view of Fig. 1 and also in Fig. 8. The gasoline drive for the mixer made it possible for the hoisting engineer to give a maximum of attention to the operation of hoisting, as the little gasoline engine required attention only at the time of changing crews, to see that fuel and oil were supplied in sufficient quantities for the succeeding shift. Hot water was used for the mixing operation from the beginning of the shell to the end of the job.

THE SLIP JOINT

Fig. 3, from a photograph taken Oct. 22, 1913, shows how the slip joint at the bottom of the wall was made. The graphite paste was spread first upon the concrete foundation and the sheet copper was laid immediately on top of this. Upon this copper sheet the wall was built.

This view shows also the construction of the wooden circular ribs of the jacking forms, supported on pieces of the segmental combination wood and plaster forms, which were previously used to secure the smooth wall of the elevated portion of the center of the foundation. This wall or rise is shown clearly just below the wooden rings.

PROGRESS OF FORM WORK

The illustration, Figs. 4, 5, 6 and 7, show the different stages in the erection of the jacking forms. Fig. 4, from a photo taken Oct. 26, 1913, is an "aeroplane" view, and Fig. 6 is a detail of the assembly of the wooden circular ribs of the jacking forms with the vertical jack yoke posts and

the radial truss, which supports the floor shown in Figs. 6 and 7.

The central radial truss was designed strong enough to support the dome forms after the shell had been poured. This eliminated at a stroke all necessity for a scaffolding or staging from the ground up. Fig. 6 shows the floor joists laid over the radial truss and floor boards being put down in such manner as to effect the least cutting of the lumber, as this decking was to be used again for the surface of the dome forms, later on. This view also shows the lagging of the interior forms in place and the outside form ribs in place, but not as yet lagged. It also shows at the left some of the wall reinforcement bent and piled ready for use. Fig. 7 shows the completed forms shortly after they began to move. The jacks which accomplished the vertical movement of the forms are shown at each yoke. Fig. 8 shows the arrangement of the plant and the exterior scaffold attached to the movable forms for the use of the workmen who rubbed down the exterior surface with carborundum rubbing bricks,⁵ as called for by the specification. As the height increased an outside railing was added to this hanging exterior scaffold.

Fig. 9, appearing like a spider web, is a rather novel view, looking up the interior of the completed shell, giving a bottom view of the radial truss shown in Figs. 6 and 7. This interior view also shows the hanging scaffold used on the inside of the wall, to facilitate inspection as the work progressed. In Fig. 10 is shown the falsework for the dome, and Fig. 11 shows the completed dome and battlements from above. Fig. 14 shows the standpipe as it appears from the ground in its practically completed condition, except that the exterior must be again rubbed down to remove any traces of cement leakage from the work above which has caused streaks or blotches on the surface. At the time this photograph was taken, Dec. 29, 1913, the tank had been filled with water to a depth of 96'.

Figs. 12 and 13 are progress views showing the speed made on the work.

For certain purposes broken blue glass makes an excellent finish on concrete block.

Contractors have found that it is a good thing to equip with rubber boots the men working in concrete. Wet feet are as bad as "cold feet."

¹T. L. Smith Co., Milwaukee

²Lidgerwood Mfg. Co., N. Y. C.

³This mixer is described on p. 44, Jan., 1914, issue

⁵Carborundum Co., Niagara Falls, N. Y.



FIG. 1—GARDEN VASES OF CONCRETE WITH ORNAMENTATION IN COLORED TILES—THE WORK OF STUDENTS AT THE SCHOOL OF INDUSTRIAL ART OF THE PENNSYLVANIA MUSEUM, PHILADELPHIA

Matters of Design and Execution in Ornamental Concrete Products Manufacture

STAFF ARTICLE



FIG. 2—THE BOLD DESIGN OF THIS CONCRETE FLOWER BOX SUGGESTS AN "UNDERCUT" WHICH MUST HAVE BEEN CAST IN GLUE MOLDS; YET THE WORK WAS DONE IN A PLASTER MOLD

There are two suggestions for manufacturers of ornamental concrete products in the presentation on this and succeeding pages of some examples of the work along this line done by the students of the School of Industrial Art, Philadelphia, under the direction of Charles T. Scott, who is the school's instructor in modeling and allied subjects. There is also a suggestion for architects in acquainting them with the possibilities in ornamental work in concrete.

One of the suggestions for the manufacturers is a matter of design and the other is a matter of execution.

The products manufacturer should exercise a care in buying stock molds from the manufacturers of molds to

the end that the architects who buy for clients may find what they want and that home owners who buy direct may find objects which are not only in good taste in a general sense, but which are designed with a definite view to the kind of material in which the design is to be carried out. The maker of ornamental concrete objects which are to be used in gardens, in halls and on porches should help the manufacturer of molds for those objects by telling him what kind of molds are in demand. The manufacturer of the molds will be glad to have the assistance and suggestions of his clients. A common difficulty is that there is too much design—too much for proper expression in concrete, and yet this is by

no means the rule. Excellent molds are to be had and it is largely up to the maker of ornamental concrete work to select the right ones.

The products manufacturer should go further, however, in his efforts to meet the varied demands of architects and individual buyers. It is coming to be realized more and more



FIG. 3—THE CONVENTIONALIZED WALRUS UTILIZED IN THIS CONCRETE CORBEL IS APPROPRIATE FOR THE INTENDED USE OF THE PIECE IN A POOL FOR SEA LIONS



FIG. 4—THESE THREE PIECES OF ORNAMENTAL WORK FROM THE PHILADELPHIA SCHOOL SHOW DISTINCTLY THE VALUE OF BOLD WORK AND A SLIGHTLY ROUGH SURFACE WHEN THE MEDIUM IS CONCRETE

that a man who wants to buy such ornamental products usually has some idea as to what they should be. The architect almost always has some definite scheme in mind. For this reason the products manufacturer should not be hampered by the limitations of his stock molds. He should be in a position to do special work. Of course the ideal situation is to maintain a competent modeling department so that when a man is willing to pay for an exclusive design—and of course the cost is considerably more—he can get what he wants. Yet there are many products manufacturers with whom the ornamental work is merely a side line and a special modeling and mold building department is out of the question. Such products manufacturers should, however, be able to make necessary arrangements with skilled modelers, who perhaps have a business of their own, and with competent mold makers able to use wood and plaster in such work where difficult modeling may not be required.

The important thing is that the maker of ornamental concrete products put himself in a position to offer special work to architects and the general public. The fact that he is ready for special work, that is, work requiring special molds, will be sure to bring him work which he can turn out in his stock molds. There will be a great forward movement in concrete products work when the architects and the manufacturers get closer together, when the latter show a disposition to honor the architects with a full recognition of their drawings.

The illustrations here shown, however, indicate something more than originality and attractiveness in the design itself.

Enrichment of design may be almost if not quite eliminated in many objects and yet leave a most pleasing result, if the texture qualities are interesting.

The writer has noticed in several products plants where ornamental work is done, from both stock and

special molds, and it is noticeable in the photographs of products from a great many plants, that there is an idea that smoothness is a thing much sought after. Workmen are at infinite pains to get the ornamental objects letter-perfect. The merest pinhole in the surface is not tolerated. We receive numerous inquiries as to how to get absolutely smooth, clean textures.

What is suggested by much of the work from the Philadelphia school is that its attractiveness is not in its smoothness, nor is it always a matter of design detail. It is a matter of texture. An unrelieved grayness in concrete ornamental work is frequently unattractive. And at this time the suggested remedy is not in

material such as clay has a surface which rightfully belongs to it and concrete which is of coarser grain has a characteristic surface value which is best realized in bold treatments. The rough surface is not essential in such objects as are shown in Fig. 1, where the gray of the untreated concrete is relieved by a restrained use of colored tiles. These tiles, by the way, are not used smooth side out. The tiles used at the Philadelphia school are about $\frac{3}{8}$ " thick and are split by means of mallet and chisel so that they present a rough surface. The split pieces are then inserted in the concrete work, rough side out. These tiles are inlaid, set in a rich mortar after the concrete cast is complete, spaces having been



FIG. 5—GARDEN SEAT AND BOWL OF CONCRETE

a colored mixture or in colored aggregates. The remedy is in color or tone values in the texture, the roughness—in the very lack of perfection. It is in this texture, this boldness of surface, that perfection comes nearest to realization. It must be remembered that the surface value of concrete is not at all like the surface value of terra cotta or other clay products. A sticky, fine-grained ma-

provided for them when the mold was made.

In Fig. 2 a flower box of bold treatment is shown. Although this appears to have deep undercut, and gives the impression that it must have been cast in a glue mold, it was actually made in a plaster mold, with the exercise of great care as to the direction of the deep cuts, when the model was made, so that the plaster



FIG. 6—THESE VIEWS SHOW SOME OF THE STEPS IN THE EXECUTION OF DESIGNS FOR EXPRESSION IN CONCRETE; HERE IS SHOWN THE MODELING IN CLAY FOR REPRODUCTION IN CONCRETE IN PLASTER MOLDS

would pull away. The concrete in the recessed portion of the front panel is less than $\frac{1}{2}$ " thick. A similar box has been in use several years outdoors in all kinds of weather and shows no defects and yet the mixture used was only just wet enough to ball in the hand. It was tamped in firmly (a mixture of about 1:3 with river sand) and cured with care in seeing that plenty of moisture was always present.

The course followed by Mr. Scott in curing concrete work done at the school is to cover the concrete casts, plaster molds and all, with damp cloths; the concrete work and the cloths are then entirely confined in oilcloth for the first night. The next day the work is filled with water. On the following day, the second following the casting, the mold is removed and the concrete object is put in a tank of water, where

it remains for a week entirely covered. Mr. Scott is of the opinion that 36 hrs. is about the right length of time for the concrete work to remain in the mold. During that time, the work must not be allowed to dry out, and the sooner the casts can be removed from the molds and put in a tank of water, the better it is for the work. If allowed to remain in the molds too long with only the amount of water which can be supplied by means of the wet cloths, some crumbling is apt to take place



FIG. 8—CONCRETE WORK—BOTH DESIGN AND EXECUTION—DONE AT THE PHILADELPHIA SCHOOL BY A 14-YEAR-OLD BOY; THE LOWER VIEW SHOWS THE CONCRETE CAST AS IT CAME FROM THE MOLD, AND ABOVE IS SHOWN THE EFFECT OF A RESTRAINED TOOLING



FIG. 7—FURTHER EXAMPLES OF CONCRETE ORNAMENTAL OBJECTS WHICH SHOW THE VALUE OF THE MATERIAL WHEN PROPERLY HANDLED



FIG. 9—ANOTHER GARDEN ORNAMENT IN CONCRETE WHICH SHOWS THE EFFECTIVENESS OF BOLD TREATMENT

after the removal from the molds. No finishing of the surface is done on any of the work in the school. Various methods have been tried and found unsatisfactory.

It is in this comparatively dry mix that the texture secret lies. While in the walls of a house good, dense concrete is desirable and while wetness of mix is an undeniable aid in securing this density, the field of ornamental work, at least of the character such as is here illustrated, has other ends more to be sought for than waterproofness. Many of the ornamental objects made at the Philadelphia school have been left around year after year in the school yard and have taken on a weathered and sometimes even a mossy appearance which makes the objects more in keeping with their surroundings. And while such results are not always desirable they are sometimes important and go a great way with some buyers and users of such objects.

Still more of the attractiveness of a rough texture is seen in the objects illustrated in Fig. 4. In Fig. 8, as well as in the garden vase shown at the extreme right in Fig. 4, are examples of the pleasing results obtained where great restraint has governed the design and where texture has entered into the surface.

While not illustrating any of the main points so far considered, the work illustrated in Fig. 9, done by a boy 14 years old at the Philadelphia school, contains a suggestion along a different line. The lower of the two eagles in the illustration is just as it came from the plaster mold

and the upper one is from the same mold, but tooled slightly to accentuate certain details.

Coal Particles in Concrete

It is known that sand containing coal particles, if used as an aggregate, will give inferior qualities to the concrete. A recent investigation brought forth the following interesting information:

There is quite a little difference in the effect of anthracite and of lignite coal particles. The latter cause serious cracks in the concrete and lower the compressive strength considerably. Anthracite coal particles, if near the surface of the concrete, show similar effects, although not to such a marked extent. It is supposed that the little coal particles lying just back of the concrete surface, soften and form a sort of sludge, which tends to loosen the surface finish, and often causes the cement mortar to crack and peel off in large pieces. Where the finish is waterproof, the damage is considerable, as the exposed concrete is then open to the attack of water. In such cases it is advisable to pick out the coal particles with a sharp instrument, and put on a new finish at the respective spots. The cause of the impurities is laid at the door of the railroads, which use coal cars for hauling sand and thus allow the fine coal dust to mix with the sand. Steps have been taken by the German cement manufacturers to compel the railroads to use special sand cars for transporting sand.—*Baumaterialien-Markt*.

Qualifications of a Building Superintendent

Frederick W. Taylor, in his excellent paper entitled "Shop Management," specifies 10 different qualifications which go to make up a well-rounded man, namely: "Brains; education; special or technical knowledge; manual dexterity or strength; tact; energy; grit; honesty; judgment or common-sense; and good health." He states that there are plenty of men to be found who embody three of these qualifications. Four make a higher-priced man. A man combining five is quite hard to get, and one combining six, seven or eight is almost impossible to find.

Commenting on this, L. C. Wason,¹ in a recent address, stated that if a building superintendent is to be successful, he must combine at least seven of these qualities. He must have brains, special and technical knowledge of both direct contract and sub-contract work, tact, energy, honesty, judgment and good health. He must have a personality which drives to activity several hundred originally unorganized men who are without interest in the company for which they work or in the result accomplished, and with such tact and judgment as to weld them into an harmonious working force, cheerful and self-respecting, with high morale, and ultimately with enthusiasm for the work in hand. He carries a care so great that he builds in full size, with permanent materials, the intricacies of design which trouble the engineer's drafting room to show clearly on paper; with an honor so fine that the company is ready to leave its reputation in his hands, to trust him with funds; and with special experience so trained that dangerous operations are carried on as a matter of routine, without worry to himself or the company, yet with a constant oversight of a thousand chances for accident or perhaps death which may occur to the men in his charge; with a forethought so great that he sees ahead and provides for the problems which are to come up perhaps months later; with a temper so good that he never loses self-control under the most provoking circumstances, and is able to take with the best of grace changes in his plans from the office, and to work in the close co-operation with the company which is so necessary to make it an effective contracting organization.

¹Pres., Aberthaw Construction Co., Boston

Layout and Operation of Plant for Wet Process Block Manufacture, Using Metal Molds

STAFF ARTICLE

There is one thing about the manufacture of concrete block as described in the article published here which will strike a good many products manufacturers as being unusual, to say the least, and that is the dry heat used in the steam tunnels. The pipes in the tunnel of this plant are not perforated and they are used solely for heating. The block which go into these dry heated tunnels are made with considerable excess of moisture, considerably more moisture than is required by Portland cement in developing its setting qualities. Of course such a system would not do at all where block are made only semi-wet and require every bit of moisture which goes into them to complete the hardening process. It is essential in the manufacture of such block that the atmosphere of the curing chambers be so laden with moisture that it will take no moisture from the block.

Seventeen men make approximately 1,900 block per day by the slush method in the Zagelmeyer Cast Stone Co.'s plant in Detroit. The Zagelmeyer system¹ is used. These are part 8-in., part 10-in. and part 12-in. block. Some of them are rock face and some have a plain face and some of both are faced with granite crystals. About 25% of the output is of granite faced block. A record

kept for about 80 days in the last season at the plant, showed a production of 110 block per man per day of 10 hrs—this output is based upon every man employed in the factory and yard.

The gravel comes into the plant by rail (see Fig. 2), and ordinarily when the plant is in full operation it is arranged to have cars of gravel at such times as to make it necessary to handle the gravel once only. It is unloaded into the back part of the building in the space marked "Cement Storage." (These plans were drawn before the plant was built or equipped.) Over this space from a door leading out to the railroad track is a runway for the movement of two-wheeled carts² which hold approximately 6 cu. ft. of material. The cement is piled up in bags in the space to the right of the mixer and in front of the raised runway where the gravel is handled. A bag of cement is put on the top of the cart of gravel and conveyed to the loading end of the mixer, which is toward the back of the plant, two men handling all the gravel and the cement to the mixer. The mix used is 1:5½. The mixer is a Marsh-Capron³ batch machine, and the mixture turned out for the Zagelmeyer block is soupy wet. The batch is run out from the mixer through a chute as shown in Fig. 3, into the molds on the car, which when first brought in from the transfer track is shoved

back under the mixer, so that the chute first fills the molds farthest from the mixer. The cars are gradually moved forward until all the molds are filled. The concrete is roughly leveled off, moved from the transfer track, and shoved either to the right or the left out through a wide sliding doorway into the yard. The car is then shoved over the transfer track to one of the tracks which extend out in front of the low curing chambers. The cars are left exposed for about an hour, and then the block are slightly troweled off and shoved into the steam room on the cars. This is illustrated in Fig. 4 and details of the steam room construction, piping and so on, are shown in Figs. 5, 6 and 7.

LAYOUT OF STEAM TUNNELS

As originally laid out and shown in the plans, as here reproduced, there is steam room capacity for about 1,500 block. Referring to Fig. 2, the back walls extending along these steam tunnels have been knocked out since the plant was first erected, and the tunnels lengthened, back into the space marked "Gravel Storage," so that each tunnel accommodates two cars instead of one. This has been done on one side of the plant only. The steam tunnel capacity of the plant is now about 2,000 block per day.

This arrangement of tracks and steam tunnels is duplicated on the opposite side of the plant, not shown in the drawings for lack of space, and by lengthening the bank of

¹Zagelmeyer Cast Stone Block Machy. Co., Bay City, Mich.

²Toledo Wheelbarrow Co., Toledo, O.

³Marsh-Capron Mfg. Co., Chicago



FIG. 1—A VIEW OF YARD OF ZAGELMEYER PLANT IN DETROIT

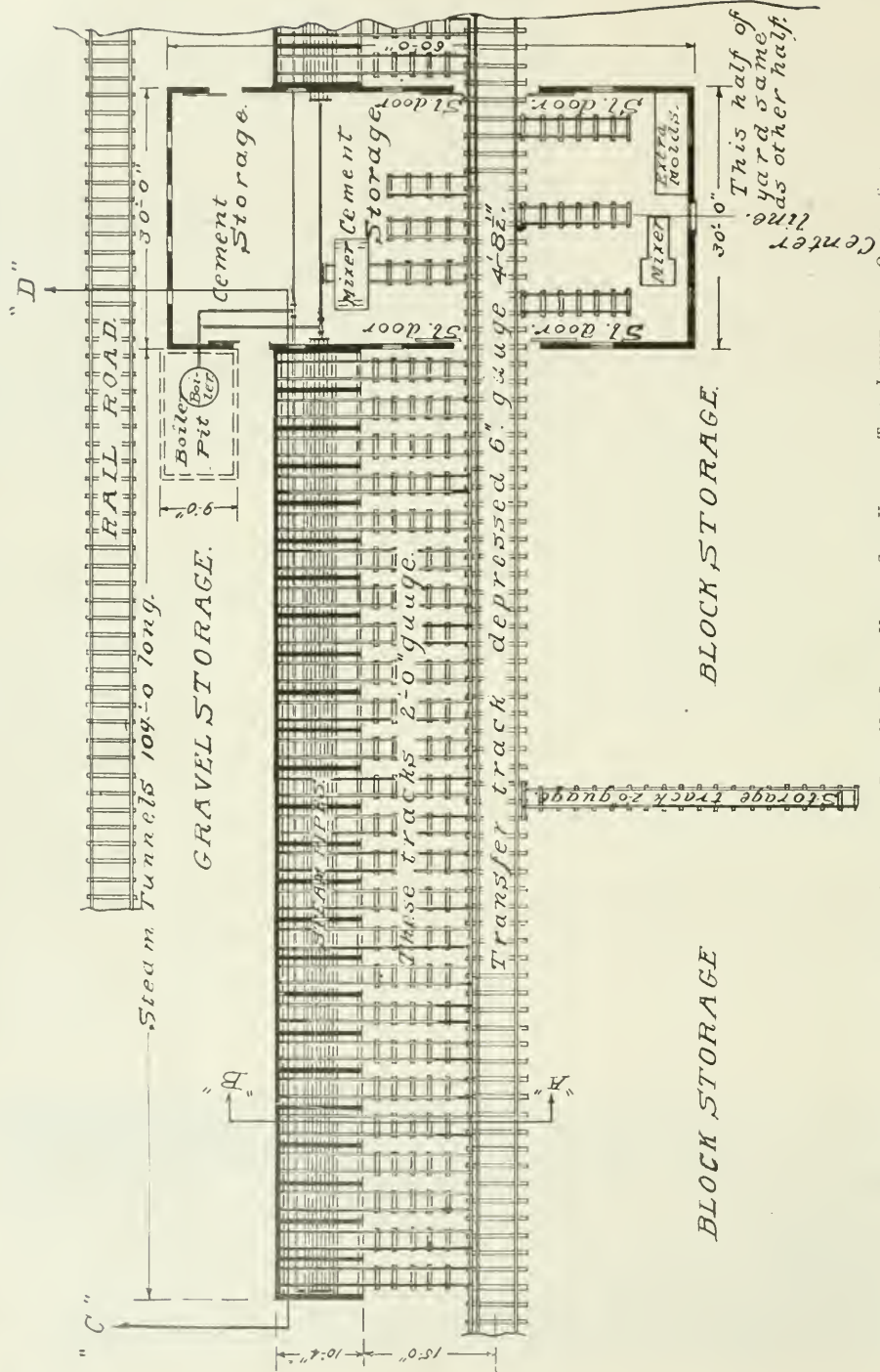


FIG. 2.—PLAN OF PLANT: THE YARD SPACE TO THE RIGHT NOT SHOWN HAS THE SAME KILN AND TRACK LAYOUT AS THE OPPOSITE SIDE

steam tunnels on this opposite side and by doubling the length of each tunnel it is proposed in the coming season to increase the capacity to 4,000 block per day. These steam tunnels are built of monolithic concrete, as indicated in the drawings, and under them is a bank of steam pipes (10 pipes) communicating with a 30-h.p. boiler. The intention, both summer and winter, is to keep the steam tunnels at a temperature of approximately 100°. This is done with very little, and sometimes no steam heat in the hot summer weather. The 30-h.p. boiler probably will be replaced by one of 40-h.p. when the tunnels are doubled in number. There is no attempt to make the atmosphere of these tunnels moist, as is the case with curing rooms designed to take care of block made under the semi-wet process.

Inasmuch as the front of each steam tunnel is built on a slant, as shown in Fig. 6, a wooden batten is laid up against the front of each tunnel after the car has been put in and the covers are held fairly tight by means of wooden buttons.

The tunnels are all numbered, and as the output of the plant is gauged by the capacity of the tunnels, it is possible to arrange the work so that a car put in the tunnel at say 10 a. m. is removed from the tunnel at about 9 a. m. the day following.

UNLOADING AND RESETTING

The wedge pieces of metal are then removed from the ends of the cores, which at once collapse, and are removed; then the division plates in the molds are taken out and the block are piled in the yard. At this stage in their curing they have to be handled with reasonable care to prevent breakage. Over the storage track, seen in the block storage yard, Fig. 2, and also over a like track on the other side of the plant, is a shelter, consisting merely of a roof and no side walls. The car is shoved under this shelter after the removal of the molds and after the block have been piled in the yard the car is brought back to this shed for cleaning, oiling and resetting the plates which form the molds. This car, now empty and ready for refilling, is shoved over the transfer track and into the factory and back over the small track to the mixer from which it started about 24 hrs. previous. It is said that two men, with practice, can unload, clean and reset 32 cars in a 10-hr. day.

A slightly different course is followed in the manufacture of granite faced and sand faced block, and at this point it is necessary to note a slight change in the arrangement of the factory from that shown in Fig. 2.

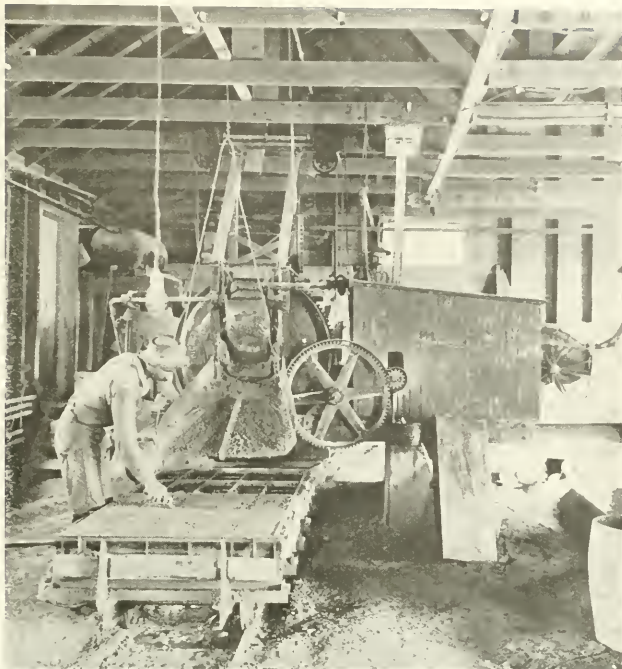


FIG. 3—FILLING CAR OF MOLDS FROM MIXER

FIG. 4—VIEW OF YARD: PUTTING CARS IN AND OUT OF TUNNELS

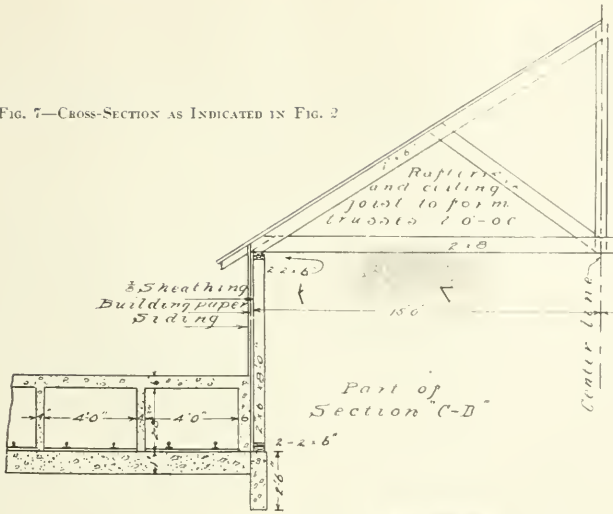
PREPARING FACE PLATES

The lower right hand corner of the factory building in the general location of the space marked "extra molds" is the office, and immediately back of this and between the office and the wide transfer track is a small space, the work of which is illustrated in Fig. 8. In this space the face plates are made ready for the granite faced block. Two men do this work, one coating the plates with glue of a thick consistency, and passing them to the other operator in this department. The second man puts a plate into a frame, which is shown in the corner of the illustration, this frame being mounted on an axle turned by a crank and connect-

ed by means of gears with a wide and shallow box under the frame. This box is divided in the center by a partition. On one side of the box is a supply of No. 3½ crushed granite,⁴ and on the other side a supply of No. 5. The operator first sprinkles the coarser crushed granite over the glue-coated face plate and then by turning a crank, tips the surplus back into the side of the box where it belongs, the box moving under the plate to receive what falls off. He then sprinkles a quantity of fine granite onto the plate, thus covering all of the surface of the plate, and the frame is then tipped in the oppo-

⁴Crown Point Spar Co., N. Y. C.

FIG. 7—CROSS-SECTION AS INDICATED IN FIG. 2



site direction, the box moving to receive the surplus which falls off. It is a very simple device,⁶ operates easily and always comes back to the center; thus the face plates are kept upright due to a heavy weight on the axle. When the face plate has been covered with granite it is put onto a rack, which is in reality a series of shelves very close together and designed to accommodate something more than three hours' supply of plates, it being considered advisable to leave the plates for about three hours, in which time the glue is allowed to set and hold the granite firmly.

"SETTING UP" FOR SPECIAL BLOCK

Referring again to Fig. 2, the mixer is not in the front of the building, as indicated. The space where the center track is indicated is occupied by a partition, partly shutting off the corner where the face plates are prepared. There is easy access to the rack, however, where the face plates are kept on the right side of the building (as seen in the sketch), from the space where the cars of molds in which specially faced blocks are to be made are set up. All the molds for these specially faced blocks are set up in this building rather than out in the yard, as is the case with the molds for the plain block. Two men do all this setting up for the special work. Close against the wall on the left side of this front portion of the building is a small Jaeger batch mixer² used for facing material. In this, cement and sand,

in the proportion of 1:2, for the exposed portions of the sand-face block, are mixed. Right here, it should be mentioned that the present plant includes, in addition to the center building shown, a shed built on to the left toward the front, and in this, extra division plates, cores and

so treated is then moved forward to the transfer track and up in front of the mixer where the concrete is put in, in slushy consistency, just as for plain block.

The sand-cement facing material used for the rock face block is put into the molds about 1½" deep, thoroughly tamped, this operation being done by the same two men who set up molds for the granite faced work. This sand-cement facing is of just about the same consistency as is used in semi-wet block manufacture, and for this facing the Zaglemeier plant is using a common fine river sand.

THE MEN EMPLOYED

The 17 men in the plant are employed as follows:

Two men feeding the mixer and handling the gravel and cement.

One man running the mixer, and filling the molds.

Two men applying the glue and granite to the face plates for the granite faced block.

Two men setting up cars and molds and handling the facing mixture for the sand-faced work, and applying neat cement on the plates for the granite faced block.

Ten men are employed in moving the cars to the yards and to the steam tunnels; removing the cars from the



FIG. 8—PUTTING GLUE AND GRANITE ON FACE PLATES

face plates are kept, and also reinforcing material used in sills, lintels and so on.

After the glue, with the granite facing, has set for three hours and the plates are set up in the molds on the car, the men who handle this facing material throw into each mold a small dipperful of cement and water in a creamy mixture to give all the particles of the granite facing a thorough bond with the concrete backing. This mixture, after being thrown on from a dipper, is brushed in, to be sure that it penetrates everywhere. The car with the face plates

steam tunnels; piling up the block, oiling and resetting the molds. One of these 10 men devotes a part of his time to the boiler, which is used only to supply steam for heat, this of course including the steam tunnels. The man who runs the mixer and fills the molds at the mixer is paid \$3.50 a day. All the other employees receive \$2.75 a day each. This is rather more than the regular price for a common laborer in Detroit, but by adopting this scale of wages, the plant is able to keep the same men and get a better quality of service.

The gravel which is used is a pit-

¹Zagelmeyer Cast Stone Block Machy. Co.,
Bay City, Mich.

*Jaeger Mach. Co., Columbus, O.

run material of fairly good quality, shipped from out in the state; it costs at this time 80 cts. per cu. yd. on the siding, and 11 cts. per cu. yd. is added to this cost in unloading the cars. The power used in the plant is furnished by three electric motors, one of 7½ h. p. for the mixer, one of 3½ h. p. for the sand-cement facing mixer, and one of 1 h. p. for the water pump, as the city water supply is not available.

The treatment of the face plates with glue for the granite facing is a patented process. As to the facility with which this work can be handled, it is said that two men being timed (and when they knew they were being timed), can apply glue and granite to four face plates per min., and on another occasion (when the men were not aware of the fact that they were timed), they turned out two and a half plates per min., so this is considered nearer their regular gait. The wetness of the concrete with which this granite facing is backed up, softens the glue so that when block are removed from the steam tunnels they come away from the plates very easily, and come clean, and the resulting surface is such that it requires no cleaning with acid or by means of a spray.

The Zagelmeyer plant has been in operation for about a year and has had no difficulty in selling its output at a very good price. Plain block, 8" x 8" x 24", are sold for 20 cts. each. Rock face block with sand facing sell at 22 cts. each and granite faced block at 25 cts. each, for either plain or rock pattern. The largest block, 8" x 12" x 24", plain, are sold for 29 cts. each; rock face at 31 cts., and granite faced at 34 cts. Although the Zagelmeyer company has had no difficulty in getting the extra 5 cts. apiece for the granite faced block, it is said that it is possible to manufacture them at much less than that in additional cost, in fact, the extra cost to turn out the granite faced block is said to be only about 2 cts. One hundred lbs. of granite-facing material is said to be enough for about 150 block, 8" x 8" x 24". Looking at the edge of one of these block, it is hard to see any thickness to the facing at all, and yet the surface is covered completely and the method of bonding appears to make it hold securely.

IMPROVEMENTS

In addition to enlarging the plant for the work of the coming season by doubling the steam tunnel capacity and by adding some cars and molds, it is proposed to put in a more economical gravel handling equipment with overhead bins, elevating

device and chutes to convey the gravel direct to the mixer.

Another consideration in the growth of business in the Detroit plant is in the fact that there is a constantly increasing demand for the granite faced block. The present plant was not laid out with that idea in view, in fact, in the last season about 25% of the output was granite faced, and the space inside the building for handling face plates, applying neat cement and setting up the molds on the cars is too small to permit of much growth of output of the granite faced material. Probably some changes will be made which will do away with the present system of racks to hold the face plates while the glue is hardening and small cars with racks will be substituted. It is also likely that more space inside will be allotted for setting up the cars for the granite faced material, and that the small cars carrying the

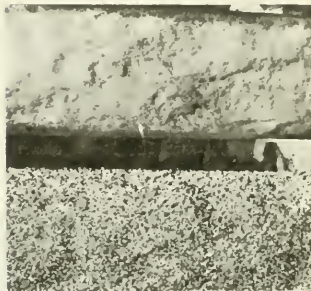


FIG. 9—A CLOSE VIEW OF A METAL FACE PLATE AND OF A SIMILAR FACE PLATE WHEN COATED WITH GLUE AND COVERED WITH GRANITE. THE PLATE WAS SELECTED AT RANDOM

granite-covered face plates will move from the department where these plates are prepared, to the men who are setting up the molds, in such a way that when a car of plates reaches the place where they are to be used, they will have set for 2½ hrs. to 3 hrs., so that the glue will be sufficiently hard.

ROCK FACE VARIETY

There is another feature, an architectural feature, which, according to the block manufacturers at this plant, works out greatly to the advantage of rock face block, particularly the rock face block which have a facing of granite. This is in the fact that 20 different plates are used to produce rock face block, and each car which goes to the mixer has one each of the 20 patterns. The result is that the block are manufactured in continuous variety and each car of block removed from the steam tunnels and piled in the yard, contains

20 different patterns, so that in making a shipment of block from the yard and in taking a selection from a given supply of the proper age, there is always the same variety of rock face design and practically the same number of each variety in any one shipment. The designs being thus mixed from the time they are manufactured to the time they are shipped to the job makes it possible to continue the variety in putting the block in the wall. The result is an absence of sameness in adjacent block.

Another product for which there is an increasing demand is a perfectly plain block without any special face, used for stucco block. The rough side of the block, which is the side which is uppermost when cast, is turned out in the wall, giving a satisfactory bond for stucco.

The Use of Reinforced Concrete in India

In surveying trade conditions in Bombay and India in general, it was noted in a recent issue of *CONCRETE-CEMENT AGE* that building stone has risen in price and that teak wood, which has been the staple building material in India for centuries, has also undergone an abnormal increase in cost. The report goes on to say that cement has increased 34% in quantity and 52% in value in the last year and that reinforced concrete structures are now seen in many sections of Bombay and are likely to be the base of all new structures such as tenements, warehouses, etc.

So it goes round the world and engineers, architects and builders are having the same experience that we have had here in past years. Reinforced concrete is the building material.

A Concrete Reservoir Used as a Pleasure Park

One does not usually think of a reservoir as a suitable playground for children, but rather as a dangerous place from which to keep the little folks as far as possible. In Reading, Pa., the problem has been very nicely settled by putting a roof over the reservoir and turning it into a pleasure park for the city. In summer it is used as a roller skating rink and in winter it is flooded and allowed to freeze for ice skating. A small pavilion adds to the comfort of those who enjoy watching the sports. The roof is well lighted with electric lights and the grounds are often used for entertainments by the grown-ups.

Road Maintenance Methods and Costs for Year 1913 in Wayne County, Michigan¹

The report published here tells how the concrete roads of Wayne county, Mich., were maintained in the year 1913 and how much that maintenance cost. Definite statements are made of material used, labor employed and the cost of each on the various stretches of concrete. The report covers work on 51 miles of concrete highway—the total amount on which cracks, joints and small holes were taken care of in the year. In supplementing the

detailed articles which have been published in this magazine describing construction methods, costs and equipment and the other articles by various authorities analyzing the work, the present report is of the utmost importance in affording full appreciation of the road building results which have been obtained in Wayne county through Chairman Edward N. Hines and his colleagues of the Board of County Road Commissioners.

Just how the Wayne Co., Mich., concrete roads were maintained in the year 1913 and just how much the work cost, are to be presented here without any reference to those features of road maintenance which are common to all highways and have no particular reference to the actual metal or hard surface of the road. The information and cost data given cover the maintenance of the concrete, including the joints, the cracks which developed in the slabs and the small holes in the surface. The cost does not include re-shaping the shoulders nor does it include cutting the weeds and cleaning the ditches along the road.

In the concrete road maintenance, the working crew is made up of seven men and a team, and equipped with a tar kettle. The foreman is paid \$5.00 a day, the team and driver \$5.00 a day, the "tar man" \$3.00 a day, two laborers at \$2.50 each and two laborers at \$2.25 each. The tools used consist of two wire bristle brooms, a wheelbarrow, a couple of shovels and a tar bucket with a round spout. Tarvia X² is now used exclusively. A lighter grade was first tried out, but did not give such permanent results as the heavier grade. Two men are utilized to sweep all cracks clean with the wire brooms, after which the man with the tar kettle fills the cracks with the tar,

which is heated to about 225° F. An excess of tar is poured in so that it extends an inch or so beyond the edge of the crack. It is then allowed to stand in the crack for a few minutes to prevent it from "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffic to iron out.

The excess tar and sand is worn away rapidly, leaving a smooth, even surface over which no jolt is apparent in passing, either with a horse-drawn or a motor-driven vehicle. This method of repair prevents the edges of the concrete from spalling and chipping, and no water can get through to the sub-grade to freeze and heave in cold weather.

The work is preferably done on hot, dry days. It has been suggested that the better time to handle this work would be in the late fall when the cracks would be open the widest, due to contraction, but the results secured in the summer months have been so satisfactory that the other plan has not been tried out. The small pit holes, which are due simply to some foreign substance getting into the concrete (like clay, wood or some fragment of inferior rock which might chance to be a part of the aggregate) are treated in the same manner. The cost of this method is presented in a verbatim report of the engineering staff of the Board of County Road Commissioners. George A. Dingman and George F. Key. See the table.

A percentage was added to cover

COST OF MAINTENANCE ON 51 MILES OF ROAD					
Michigan Ave. Road.....	Tar	20	bbls. at \$ 6.00	\$120.00	
17 miles	Labor	10	das. at 22.50	225.00	
	Sand	18	yds. at 2.50	86.00	\$ 331.00
Grand River Road.....	Tar	14	bbls. at \$ 6.00	\$ 84.00	
10 miles	Labor	6	das. at 22.50	135.00	
	Sand	8	yds. at 2.00	16.00	285.00
Gratiot Road	Tar	3	bbls. at \$ 6.00	\$ 18.00	
1½ miles	Labor	2	das. at 22.50	45.00	
	Sand	4	yds. at 2.00	8.00	71.00
Jefferson Road	Tar	6	bbls. at \$ 6.00	\$ 36.00	
1¾ miles	Labor	2	das. at 22.50	45.00	
	Sand	4	yds. at 2.00	8.00	89.00
Van Dyke Road.....	Tar	5	bbls. at \$ 6.00	\$ 30.00	
2 1/3 miles	Labor	1½	das. at 22.50	33.75	
	Sand	4	yds. at 2.00	8.00	88.00
Mt. Elliott Road.....	Tar	3	bbls. at \$ 6.00	\$ 18.00	
1½ miles	Labor	1½	das. at 22.50	33.75	
	Sand	4½	yds. at 2.00	9.00	60.75
River Road	Tar	10	bbls. at \$ 6.00	\$ 60.00	
7 miles	Labor	5	das. at 22.50	112.50	
	Sand	12	yds. at 2.00	24.00	196.50
Eureka Road	Tar	4	bbls. at \$ 6.00	\$ 24.00	
4¼ miles	Labor	2	das. at 22.50	45.00	
	Sand	4	yds. at 2.00	8.00	77.00
Wayne Road, South.....	Tar	1	bbl. at \$ 6.00	\$ 6.00	
½ mile	Labor	¾	da. at 22.50	11.25	
	Sand	1½	yds. at 2.00	3.00	20.25
Woodward Ave. Road.....	Tar	5	bbls. at \$ 6.00	\$ 30.00	
2¼ miles	Labor	2	das. at 22.50	45.00	
	Sand	6	yds. at 2.00	12.00	87.00
51 miles	Total				\$1,309.50

¹This statement is official and comes from Wayne county road authorities.—Editors

²Barrett Mfg. Co., N. Y. C.

engineering inspection and the depreciation of machinery, buildings and other "overhead" charges, making the total approximately \$1,450. This cost report covers the fiscal year of the Board from Oct. 1, 1912, to Sept. 30, 1913, inclusive. The greater part of this mileage was treated for the first time.

Commenting on this maintenance work, Commissioner Hines says: Once a year is often enough to go over the work and touch it up here and there, as we have found by experience that most of the repairs previously made are intact.

We have not had so good success in treating the entire surface of a road where the concrete from any cause has not stood the wear. One-half mile of concrete on Fort road built on contract, about 800 ft. on Grand River road built on contract, and one and three-quarter miles on Gratiot road (built by the county), out of the 80 odd miles of concrete road in Wayne county are not up to the standard of the balance of the construction, and they have been surfaced with Dolarway,³ a special grade of Tarvia and Tarvia X. The surfaces of Fort and of Gratiot road were both rough, having been built in cold weather, and opened for traffic before the concrete had thoroughly hardened. Fort road was surfaced by the contractor before the Board would accept the road and make the final payment. It carries a fairly heavy mixed traffic, not so great, however, as either Grand River or Gratiot road. On Fort road a special grade of Tarvia was used. The road was first swept by a street sweeper, which was followed by men with wire brooms. About 1½ gal. of bitumen to the sq. yd. was used, and the whole covered with coarse sand and rolled with a 10-ton roller. This repair was made early in the summer and was not touched in any manner for a period of two years. By this time it had scaled off quite badly in spots, and was gone over again in the summer of 1913, using Tarvia X and a washed roofing gravel about ¼-in. in size. We have no record of what the first cost was to the contractor, as we paid nothing for it.

Gratiot road was surfaced at cost to us by the Dolarway people in the spring of 1912. By the summer of 1913 about half of the original coating had scaled off; at that time we patched it up, using a special grade of Tarvia and Tarvia X. The Tarvia X has given the better result to date. Washed roofing gravel was used with the bitumen. This work was also rolled with a 10-ton roller.

Gratiot road carries an average traffic of more than 1,000 vehicles a day, the largest percentage of which is motor-driven. (On the last count made one week in August and one week in September, the average traffic per day was 1,210, of which 36% was motor traffic and 64% horse-drawn vehicles.) The surface of the road is wavy, and we have found it necessary to go over the work two or three times in the summer, touching up small spots where it has scaled off here and there. The cost of the work done by our Board is in the neighborhood of nine cts. a sq. yd.

Work for Improvement of State Road Laws

All officials in direct charge of the roads of the various states will be appointed instead of elected, the civil service system will be applied to all minor officials, road taxes will be collected in cash instead of being worked out on the roads by the farmers, and general state control of roads, rather than local control, will be evolved, if the plans of the joint committee of the American Highway Association and the American Bar Association are brought to a successful conclusion.

A comprehensive program for improving the system of road management in all the states was mapped out at a meeting of a committee of the American Highway Association and representatives of the American Bar Association in New York within the past few days. The committee of the American Highway Association is composed of P. T. Colgrove, president of the Michigan Good Roads Association, an affiliated organization; A. N. Johnson, State Highway Engineer of Illinois; J. E. Pennybacker, executive secretary of the American Highway Association, and A. B. Fletcher, State Highway Engineer of California. This committee conferred with Frederick E. Wadhams, chairman of a special committee appointed by the Bar Association to take action on the subject of uniform highway laws, and with Charles Thaddeus Terry, chairman of the standing committee of the Bar Association, on uniform legislation.

As the first step in the program for uniform highway legislation, it was determined to obtain the assistance of the government Office of Public Roads and all the state highway departments in the preparation of a complete literal compilation of all laws on the subject of roads. It is not the intention of the committees,

which are working together as a unit, to make a digest of the laws. The statutes of the different states will be recorded in their entirety and when the compilation is completed the governors of the various states will be asked to request the legislatures to appoint committees to meet with the officials of the American Highway Association and the American Bar Association. The laws of the various states will then be at hand for comparison and correlation.

Certain basic principles will be recommended for enactment into law by all the states, such as the establishment of non-partisan boards which will select all engineers in direct charge of roads with a view to removing the chief road officials from politics. It will also be recommended that the road chiefs be selected for periods determined by their usefulness, rather than any set term of years. Aside from the basic principles, which it is believed will provide general efficiency in all the states, the legislators of the different states will be asked to evolve from the compilation of laws such legislation as will be best adapted to the needs of their own state, with an eye to nation-wide uniformity.

What the American Highway Association, the central organization working with state associations in all the states, stands for in relation to federal aid in the improvement of highways, was explained by J. E. Pennybacker, secretary of the Association, when invited to appear before the Good Roads Committee of the House of Representatives. Speaking for the 2,000 members of the American Highway Association, Mr. Pennybacker stated that the Association stood for a co-operative plan rather than the extreme of either centralization or localization, and that the roads carrying the heaviest rural traffic should be the first to be improved by federal aid. Mr. Pennybacker was requested by members of the committee to outline his personal views, and he said frankly that he believed that a distribution of government funds on a "pork barrel" basis would do great harm. To avoid the suspicion of this, he said, the state would be taken as the smallest unit for federal aid. The government will then have to deal with only forty-eight parties; whereas, if it gives federal aid to townships, it would have to deal with 29,000 townships or districts. He believed in co-operative plan, rather than the direct distribution of funds.

³Dolarway Paving Co., 95 Liberty St., N. Y. C.

A Review of the Whys and Hows of Concrete Road Construction¹

By LEWIS R. FERGUSON²

The history of our country is replete with instances in which the ingenuity of our engineers has been called upon to meet difficulties due to changed conditions and new problems involved.

That necessity is the mother of invention was never more forcibly illustrated than in the development of the concrete road. Within the last few years there has been a great factor in traffic conditions, and it has caused grave concern on the part of highway engineers and those interested in road construction. This is the heavy motor truck. Practically everyone realizes the imperative necessity for improved roads.

THE NECESSITY OF GOOD ROADS

The growth of public interest in improved roads has, within the last few years, been nothing short of marvelous and will be recorded by historians as marking one of the most important epochs in the history of our country. In cities we recognize permanent roads as essential to our very existence. For example, imagine the condition of affairs in Philadelphia with pavements no better than our country highways. The traffic of the city would be halted, and its industrial and commercial life become stagnant and blighted. But in this day even the man in the suburbs demands first-class roads. The value of his property and the comfort of life depend to a great extent, if not altogether, upon good roads, for his greatest asset is his ability to travel readily to and from the city. The farmer already understands what good roads will mean to him, and this touches all classes, for the prosperity of the whole country depends, in a large measure, upon the wealth produced from the soil. The migrations of the past few years from country to city have become a serious menace through the depopulation of agricultural districts. The cause of this movement away from the farm is almost wholly due to lack of good roads. At certain seasons of the year the farmer and his family are practically isolated. It is even difficult for country children to attend school at certain seasons, and social inter-

course becomes a task rather than a pleasure. Business is suspended and crops cannot be moved. Is it any wonder that a spirit of unrest prevails among our farmers? The farmer's bad roads represent a vast waste of his resources and opportunity. In the spring months, when prices for early farm products are highest, the roads are usually so bad that he cannot get to market. If the roads were in a good condition the entire year, there would be a more even distribution of farm products in our markets and both the producer and the consumer would be greatly benefited. The railroads have awakened to the importance of good roads. In the season of heavy transportation it is most essential that freight be delivered as uniformly as possible. In this way the number of cars required can be determined and the least delay will occur in loading. If at this time the roads become impassable, due to heavy rains or thaws, all calculations are upset. The cars stand idle for a time and then when hauling can be started again, the produce comes more rapidly than it can be handled. It is piled on the platforms to the point of congestion if it does not spoil. Both the railroad and the farmer suffer serious loss.

With the widespread interest in good roads and the growing knowledge of their importance, it is surprising to learn that less than 10% of all of our highways are improved. It is still more surprising to discover that there is a great hesitancy on the part of many, and an absolute antagonism on the part of others, when an extension of our present system of improved roads is suggested. It is only necessary to point to the recent defeat of the proposed bond issue in this state (Pennsylvania), and very significant is the attitude of the farmers who make the boast that they were the cause of its defeat.

THE COST OF MAINTENANCE

Why should there be such antagonism on the part of anyone to an extension of improved road systems? The cause is largely one of cost—not first cost of construction, for people are willing to spend money to build roads—but the everlasting cost of maintenance. In too many cases the

cost of maintenance far exceeds the interest on the bonds used to build the roads, and it is not unusual for the roads to wear out long before these bonds mature. No one enjoys paying for a dead horse. Maintenance cost brings us to the most important factor in modern highway construction.

Accurate maintenance costs for improved roads are very difficult to obtain, but an average figure can be secured from various highway reports. In Lower Merion township, a suburb of Philadelphia, there is spent about \$640 per mile per year on existing roads. This includes resurfacing of worn out roads, but not rebuilding.

The cost of repair and maintenance in Massachusetts in 1912 was \$667 per mile. In New York \$1,009 per mile was spent.³

The average cost for the last five years for maintenance and repairs in Connecticut, Massachusetts, New Jersey, New York and Rhode Island was \$649. In 1912 it amounted to \$814.³

In 1911 the appropriation for road work in Rhode Island was \$200,000, of which \$80,000, or 40%, was for maintenance.

The report of the Good Roads Committee of Monroe county, N. Y., for 1911 gives some interesting data regarding the life of the macadam type of pavement having an oiled surface. It is claimed that this county has the largest value of farm products of any county but one in the U. S., and therefore has paid special attention to its road construction and maintenance. Up to Nov. 1, 1911, there had been constructed 177.7 miles of improved highways, including state and county systems; approximately 50% of these are plain macadam with oiled surface, of either hot or cold application. The first roads built under state and county aid were put down in 1899, and additional roads have been built every year since except in 1910. Of the total 200 miles built or under construction at the time of the report, all but 33.56 miles have been water-bound macadam. All roads have since received surface treatment except 6.8 miles. The average construction cost per mile was \$8,371; the average cost of maintenance per mile per year, \$471; and the average age of the state roads has been 6.1 years. The total original cost of the 200 miles was \$1,374,469, and the total maintenance cost has been \$457,683, or a total of 33% of the original cost. One road approxi-

¹Read before Engineers' Club of Phila., Dec. 26, 1913

²M. Am. Soc. C. E.

³Bulletin No. 48, U. S. Dept. of Agriculture, Office of Public Roads, "Repair and Maintenance of Highways"

mately 4.7 miles in length was constructed in 1908 of tarvia-bound limestone at a cost of \$10,125 per mile. The average maintenance cost per year for the three years of its existence has been \$588 per mile, or, in other words, the maintenance cost for three years has been 17% of its original cost.

According to Col. Spencer Crosby, U. S. A., in charge of Buildings and Grounds for Washington, D. C., the cost in Washington of oiling macadam roads with an asphaltic oil in 1911 was from 1.2 cts. to 4.6 cts. per sq. yd. per application, exclusive of the gravel or stone screenings, which required about 1 cu. yd. for every 75 sq. yds. to 125 sq. yds. of surface. Various kinds of emulsions were tried, but it was found that the effect of each application lasted from two to three weeks only, depending upon the amount of rain, etc.

Is it any wonder that a discussion of highway construction almost invariably develops the fact that the cost of maintenance is a most essential feature in economic road work? Highway engineers throughout the country recognize the fact that some form of permanent binding material must be used if roads are to hold together under the severe conditions of traffic to which they are now exposed. This binder must be one which will not disintegrate under climatic changes. It must give a road suitable for use in the hot summer months as well as in the cold winter months. The road must not become dusty in dry weather, nor must it become muddy in wet seasons. The concrete road has a binder which increases in strength with age. A binder of Portland cement is not affected by climatic changes. While it is within comparatively recent years only that concrete roads have been extensively built, there are a few examples of concrete roads that have been constructed for a sufficient length of time to furnish us with interesting data relative to maintenance cost.

The earliest concrete pavement of record was laid in Bellefontaine, O., in 1893-4. There has been an expenditure for maintenance and repairs on this street of about $\frac{1}{4}$ of a cent per sq. yd. per year in the first 20 years of use. The surface of this pavement was scored to imitate the joints in a brick or block pavement, the idea being that this scoring was necessary to prevent the surface from being slippery. Today this pavement is in excellent condition, with the exception of a few grooves worn in the longitudinal joints.

A concrete alley was laid in the down town district of Richmond,

Ind., in 1896, and shows practically no wear at the present time.

In Wayne county, Mich., there are now about 90 miles of concrete road. The first work in this county was done in 1909. Maintenance charges on the roads for the last year were about \$26 per mile. On the score of maintenance costs concrete makes an ideal type of road for country highway purposes.

[Editors' Note—We believe that Mr. Ferguson has slightly understated the Wayne county maintenance cost for concrete roads in 1913. According to the Seventh Annual Report of the Commissioners, the cost for tarring all cracks and joints was slightly more than \$24 per mile, on roads laid previous to 1913. This included 1912 work, on which little had to be done. Yet this figure does not include bituminous resurfacing, nor does it include reshaping shoulders, cleaning ditches and cutting weeds. See article elsewhere in this issue giving definite figures on Wayne county road maintenance.]

CONSTRUCTION COSTS

The cost of the construction of every type of road depends to a great extent upon local conditions, such as the cost of grading, the cost of labor, the condition of the sub-grade, cost of materials and the method of construction. Taking an average of practically all the concrete roads of which we have been able to secure records, amounting to over 10,000,000 sq. yds., constructed throughout the U. S., the cost is \$1.26 per sq. yd., or about \$12,000 per mile for a 16-ft. road.

State Highway Commissioner Bennett of Connecticut, in a recent statement, said that bids on concrete roads in his state were running less than \$1.00 per sq. yd., including grading.

The contract price for three miles of concrete road with bituminous top, built at Bethayres, Pa., this year, was \$1.10, exclusive of grading.

Maryland has made a remarkable record in the construction of concrete roads, costs in some instances not exceeding \$9,000 per mile of 16-ft. road.

Any road building material which is to give satisfaction must be suitable both for horse-drawn and motor traffic.

GOOD FOOHOLD

The concrete road, and I am speaking of a concrete road with a concrete wearing surface, fulfills both of these requirements. I have had occasion to inspect many miles of roads built of concrete, and with concrete wearing surfaces, and have taken particular pains to interview as many drivers as possible, in order

to discover the effect on horses. I have found not a single instance in which the driver of a horse stated that any injurious effect was noted. Owing to the low tractive resistance of concrete, the horse is able to pull a far heavier load with much less effort in all seasons of the year than over any other type of country road. In Wayne county, Mich., to which reference has been made, the concrete roads have been extended to practically every part of the county, and the farmers are a unit in giving the highest endorsement to them. The only criticism to which the highway commissioners have been subjected is that they have not extended the system of concrete roads more rapidly.

On an inspection trip over a concrete road in Warren county, N. J., we had an interesting talk with a veterinary surgeon who had had a particularly good opportunity to observe the effect of this road on horses. He was a user of the road and gave it his unqualified approval, stating that instead of being injurious to a horse, he believed that it was actually beneficial.

A concrete road, owing to the impervious nature of the material of which it is constructed, and the rapidity with which water will run from it, is built with a crown of only $\frac{1}{4}$ " to the foot. This provides for a sure and even foothold for the horse. Instead of the horse's hoof meeting the surface of the road at an angle, it comes down upon an almost flat surface. On a concrete road there are no loose stones and no tendency for the horse to twist knees or shoulders. Anyone who has been over a concrete road will be convinced at once that the surface is not slippery. The most injurious slipping effect of any type of road is caused by the side slip and not by the front or back slip. Here, again, the low crown of the concrete road offers an important advantage and safeguard for horses.

Trolley lines run beside many of the roads in Wayne county. A thorough canvass of the conductors, whose cars parallel these concrete roads, brought out the fact that not one had ever seen a horse fall on these roads.

Resiliency is a question greatly discussed by highway engineers and it is often thought an essential requisite. That this is to a great extent a fallacy is seen when one considers a brick street or an asphalt street in winter time, laid on a concrete base. Certainly a Belgian block surface, laid with grouted joints on a concrete foundation, possesses no resiliency, and yet, for the heaviest kind of traffic, this type of pavement has, among many teamsters, by far the greatest

preference over any other type of street surface.

Another distinct advantage of the concrete road, due to the low crown, is the fact that the whole width of the road is available for traffic and there is no tendency to drive continuously in the center. The wear is, therefore, distributed over the entire surface.

For the motor-driven vehicle it is obvious that the concrete road is an ideal highway. Its low crown and even surface, the latter of a texture sufficiently gritty in dry or wet weather to obviate any possibility of skidding, makes it safe and comfortable for either low or high speeds under any conditions. Water flows rapidly from the dense and even surface of the concrete, thus preventing the formation of ice during the freezing months.

TO STAND HEAVY TRAFFIC

Heavy motor trucks are becoming more and more popular. The concentrated load they bring to the surface of a road is enormous. It is becoming a common sight to see motor trucks, carrying a load of as much as 10 tons, traveling over our highways at speeds of 15 miles an hour or over. Sixty per cent of this load is on the rear axle and is concentrated over a very small area under the rear wheels. To distribute this load to the sub-base, which, in truth, is the function of a road surface, requires a firm and strong medium. The constituents of the road must be held rigidly together. Engineers recognize the fact that in city streets, where traffic is heavy, the pavement must have a firm and absolutely unyielding foundation. Today it is just as essential for our country roads to have such a foundation. Both the heavy motor truck and the fast moving automobile exercise a tremendous tangential shearing force on the road surface. This force has a tendency to dislodge or shove slightly out of place any particles not held firmly in position. It has been thought that the speed at which the vehicle moves determines to a great extent this disintegrating effect. I believe, however, that the exertive horse power of the machine is, to a far greater extent, the determining factor. In any event, the surface of the road must be of such a character that it will be neither moved nor dislodged, which means that the binding material used to hold the component parts of the road in place must be strong enough to prevent even creeping of the surface. In many types of roads we find that after a comparatively short time of use the surface becomes wavy. The cause of this waviness is at present

being investigated by many highway engineers.

Sometimes unusual conditions arise which particularly favor the use of concrete. In Selinsgrove, Pa., a section of a road is subjected to flooding from an adjacent stream and each year the road washed away. In 1911 a concrete road was constructed and is at present in excellent condition.

In Whitehall, Baltimore Co., a similar condition existed and the difficulty was also overcome by building a road of concrete.

At LaSalle, Ill., the Illinois river rises, in flood times, to a height of 15' and submerges the surrounding country. The only permanent road built here is of concrete, as this material is in no way injured by water.

In building a concrete road the sub-base is rolled in the usual manner with a medium weight roller. A foundation dry and firm, with a covering that will not allow water to pass through it, is the chief characteristic of a road of the best type. If the sub-soil is of a character to retain water, it is very important that such a system of underdrainage be installed as will carry the underground water from beneath the road.

With the water taken care of, the sub-base should be compacted until there is no creeping in front of the roller. The evenness of the sub-grade is of great importance. There must be no humps or depressions. The concrete must have every opportunity for easy movement in order to adjust itself to temperature and moisture changes. When a mixer is used it should be run on planks in order that the sub-grade may be kept in good condition.

For roads up to 16' wide the base should be flat and all the crown thrown in the surface. At all times the sub-base must be thoroughly wet before any concrete is placed upon it. Particular attention must be paid to this during the dry summer months. If this is not done water will be absorbed by the base and there will not be the required quantity in the concrete to allow uniform set and strength. Should the work be a country road, forms are set in place and the space between them filled with concrete. If a city street, the curbs or gutters act as side forms.

THICKNESS

The thickness of the concrete at the side of the road determines the height of the forms. This is usually not less than 5". A crown of 1/100 the width of the road, or a slope of $\frac{1}{4}$ " to the ft., is all that is needed. By making the sub-base of a 16-ft. road flat the thickness of the

road would then be 5" at the sides and 7" at the crown. If the road or street is wider than this the sub-base can be crowned slightly, just enough to give the same 5" at the side and 7" at the crown.

The forms are usually made of 2-in. plank securely staked to line and grade. If much work is to be done it is economical to have the upper edges bound with steel. Concrete in a road is subject not to a gradual pressure as it is in most other forms of construction, but to a series of sharp, short blows over a very small area. It is, therefore, necessary that the mixture be quite strong. The proper proportions should be determined in each individual case, but experience has taught that nothing leaner than 1 part Portland cement, 2 parts sand and 4 parts gravel or broken stone should be used, and this only when the aggregates are properly graded to secure the maximum density. An excess of mortar is required to hold the large aggregate rigidly in place, and in Wayne county they are now using a mixture as rich as 1:1½:3. The concrete should be mixed quite wet for ease of workmanship and the proportions should be exactly determined for each batch, and a uniform amount of water should be used.

MIXERS

Several types of mixers have been used for concrete road construction. The traction type with a swinging boom extending in back and arranged so that a bucket runs from the mixing drum to the end of the boom is probably the most popular. With such an arrangement the concrete can be deposited the full width of the road with a minimum of re-handling. These booms are usually made about 20' long so that it is necessary to move the mixer only once to every 18 lin. ft. of road constructed.

Mixers with inclined chutes have been employed; also stationary mixers moved at more or less frequent intervals, the concrete being distributed by means of wheelbarrows, two-wheel buggies or horse-drawn concrete bottom-dump carts. While the concrete is being placed particular care should be exercised to prevent disturbing the rolled sub-base.

SURFACE FINISH

As soon as it is placed and spread the concrete should be struck off by means of a template cut to the proper shape of the road. This rides on the side forms and where possible is drawn forward with a sidewise motion to produce an even surface. It is usually made of a plank 2" x 8", about two ft. wider than the road and with the lower edge steel bound.

Very little tamping is necessary to bring mortar to the surface and this can all be done with the template. As a rule a small amount of floating must be done to remove any rough or irregular places left after using the template. A wooden float should be used. The time between using the template and floating depends upon the condition of the weather, but is usually about 1 hr. Care should be taken not to overtrowel, which will bring to the surface too much fine material.

Floating should be done from a suspended plank or bridge spanning the road and resting upon the side forms. Then there will be no danger of disturbing the wet concrete by placing planks upon it or by the finishers trying to take in too large an area without moving, which involves stepping upon the surface. Such a bridge is cheap and has the added advantage of allowing the workmen convenient passage from one side of the road to the other.

The edges should be beveled when the concrete has hardened sufficiently, if stone or earth shoulders are to be built.

CURING

To be safe in case of sudden rain, a hot sun or high wind, at least 100' of canvas should be on the work. When used it should not be allowed to touch the concrete.

When the concrete is sufficiently hard to resist pitting of the surface, it should be sprinkled with water. This cannot usually be done until the day following the laying. At this time the surface should be covered with about 2" of dirt or sand, which must be kept continually wet for one week.

It is essential to cover and keep wet a newly made concrete road. If this is not done, the concrete will not have sufficient strength to withstand the stresses brought about by contracting while hardening, and cracks will appear. These may not be harmful but they are unsightly and they cause the road to be unjustly condemned.

JOINTS

In a concrete road it is necessary to provide what are known as expansion or contraction joints, which are spaced from 25' to 35' apart. The most economical distance has not yet been determined, but these distances are used by engineers based upon the best results which have thus far been obtained. All joints should be made about 1/4" wide and filled with some elastic medium. It is advisable to protect the edges of the joints with steel plates.

WIDTH OF ROAD

Ordinary country traffic does not require a very wide road. By the use of concrete a road can be built which will meet the requirements and in order that vehicles may pass without getting into the mud it is advisable that a stone or gravel shoulder, from 2' to 4' wide, be built along each side. The shoulder should be of the same depth as the concrete, but need not be of very strong construction, since it has to bear the weight of only one wheel now and then.

In determining the amount of traffic a newly constructed road, which is to take the place of one badly worn out, is likely to be called upon to bear, judgment must be exercised. The new road will attract a great deal more traffic than did the old road, and this must be provided for.

BITUMINOUS SURFACE

In certain cases engineers have deemed it advisable to apply a thin bituminous wearing course to the surface of the concrete road. Usually about 1/3 of a gal. to the sq. yd. is used, the bitumen being applied hot, either from buckets or sprinkling cans or from tanks under pressure.

With the latter method, by means of which bitumen impinges on the concrete under a pressure of from 40 lbs. to 60 lbs., the best adherence is secured. While the surfacing material is still hot, it is covered with a layer of grit or pea gravel, sufficient material being used to absorb any excess of bitumen.

The greatest objection to a road built in this way arises from the fact that there is a feeling on the part of those building the road that the concrete simply acts as a foundation, and that for this reason a considerably leaner mixture can be used than would be the case in a road where the wear comes directly upon the concrete.

As a matter of fact the bituminous surface invariably wears off in patches. These patches are not immediately repaired, and if the concrete is not made sufficiently rigid a hole or rut forms under traffic which often causes an unjust condemnation of concrete roads. I have noted many instances in which the first concrete paving was covered with bitumen. At the end of the first year this coating has worn off to a greater or less extent and the next year's work is usually placed without any bituminous covering whatever.

TWO-COURSE WORK

In some localities it is difficult to obtain an aggregate of suitable quality for the wearing course of a concrete road. In such cases the diffi-

culty can be overcome by building what is known as two-course work. This consists of a base mixed in the proportions of 1 part cement, 2 parts sand and 4 parts aggregate, upon which is placed a wearing course about 2 in. thick of imported aggregate. The proportions in which the wearing course is to be mixed depend to a great extent upon the quality of the aggregate used. As a rule a rich mixture is employed, usually about 1 part cement, 1 part sand, 1 1/2 parts aggregate. The aggregate is generally somewhat smaller than that used for the base or for one-course work. The second course should always be placed as soon as possible after the base has been laid. In no case should an interval of more than 30 min. elapse between the laying of the two courses.

In order to obtain satisfactory results a perfect bond must be secured between the two courses. This cannot be done if any dirt or foreign matter is tracked over the first course before the wearing course is placed.

REINFORCED CONCRETE PAVEMENT

For roadways or streets over 20' in width reinforcement is used in the concrete. The method of construction in this case is to lay a thickness of about 4 in. of concrete; upon this is spread the reinforcement and, as soon as possible, the balance of the concrete necessary to bring the road up to the proposed grade is placed. In this case also particular care must be exercised to secure a perfect bond between the two courses, and the finished surface must be laid within 30 min. after placing the concrete under the reinforcing.

The best type of reinforcement to use is a wire mesh with the heavy strands running transversely across the road. The reinforcement is laid so that it does not cross the joints in the road.

The enormous increase in the yardage of concrete roads throughout the U. S. proves that its advantages are being rapidly recognized by highway engineers.

The 1913 output of cement in the U. S. is estimated at 90,000,000 bbls. Some energetic statistician has stated that this would fill 529,000 freight cars of 30 tons capacity. These cars, consolidated in one train, would reach from Portland, Me., to San Francisco and from San Francisco to Los Angeles. If these 90,000,000 bbls. were all handled in sacks it would mean, of course, 360,000,000 sacks of 95 lbs. each. If these were set end to end they would go around the world about six times.

February, 1914

Cost of Concrete Pavement, Iowa State College, 1912 and 1913

By JOHN S. Dodds¹

Concrete paving to the amount of 7,567 sq. yds. was laid at the Iowa State College in 1912 with a cost as follows:

	Unit Cost
Engineering and superintendence	\$ 524.91 .0693
Labor	1,459.62 .1930
Teaming	1,568.45 .1810
Gravel and sand from pit on campus one-third mile from work	575.89 .0761
Cement	2,337.77 .3016
Crushed rock	390.30 .0516
Asphalt for filling joints	31.48 .0042
Tools, lumber, etc.	303.57 .0401
Depreciation on mixer at 10%	165.00 .0210
Incidentals, repairs and supplies	206.77 .0272
	\$7,363.76 .9737
Less tools on hand	164.00 .0217
Cost of 7,567 sq. yds. of 1:2:4 concrete 7" thick	\$7,199.76 .9520

The low cost of gravel was due to short haul and no freight charges. The crushed rock was used to supplement local supply of coarse aggregate.

This pavement averages 28' in width and is 6" thick at curb and 7½" at center, mixed 1:2:4 in a Koehring² street paving mixer. One-half inch expansion joints were placed at 30-ft. intervals, transversely, and along the curbs. These expansion joints are unarmored and made up from tarred felt and asphalt to the required thickness.

The pavement was sprinkled constantly for one week after placing and has given excellent service up to this time.

PAVEMENT LAID, 1913

Concrete pavement to the amount of 10,474 sq. yds. was laid at the Iowa State College, Ames, Ia., in 1913, under direction of the State Highway Commission at a unit cost of 1.06 as shown by the following table:

COST PER SQ. YD.

Engineering	\$0.04407
Labor—	
Foreman	\$0.01167
Operating mixer	.02833
Finishing concrete	.02487
Charging mixer	.04673
Placing concrete	.01656
Setting forms	.01023
Preparing sub-grade	.05265
Protecting work	.00417
Hauling material and supplies	.01526
Supplying water	.00932
plant	.00584
Gravel pit operation	.02581
	\$0.23857 .23557
Teaming—	
Preparing sub-grade	.06530
Hauling material, etc.	.04835
Stripping, 1912	.02387
	.13732 .13752

Material—	
Cement (11,246 bags)	.37014
Crushed rock	.14551
Sand and gravel	.02442
Expansion joints	.00930
	.51967 .54967
Supplies	.04110
Depreciation, 10% of \$3,165.80 (value of plant Jan. 1, 1913)	.03022
Repairs: roller, mixer, gravel pit plant	.01612
	\$1.06046

This concrete work was laid with student and convict labor at \$2.50 per day. The average gravel and sand haul was two-thirds of a mile and cement cost 9 cts. per bag more in 1913 than in 1912. Construction work was similar in 1913 to that of the year before except that less crown was given to the pavement and commercial, built-up expansion joints of asphalt felt were used and placed at 50-ft. intervals, with contraction joints provided for at 12-ft. 6-in. intervals. The mix was also changed to 1:1½:3. This work was done in very hot weather and the sub-grade was kept well sprinkled and the concrete was kept wet constantly for eight days after being laid. This pavement, together with that laid in 1912, was covered with a bituminous top coat of liquid asphalt sprayed on with steam, 1/3 gal. to the sq. yd. and covered with sand at a cost of about 3½ cts. per sq. yd.

This top coat was put on to relieve the glare and reduce the noise of the concrete adjoining the college buildings.

It is expected that this pavement will be especially well adapted to Iowa conditions and can be built, where concrete materials are readily available, at a very low cost.

Great care must be exercised in the selection of material and water must be used liberally in all the operations of the work. Dirty material has been the chief cause of failure in concrete road work and local supplies should be examined carefully to ascertain their character as proper concrete road material.

Washing and screening should be practiced in many cases to secure a good quality of sand and gravel.

H. H. Althouse, formerly Ch. Engr. of the Erie R. R., has opened an office for consulting practice at 172 Fulton St., N. Y. C. He will specialize in railroad work, grade crossing elimination and coal and ore handling machinery.

Absurd Errors of Inexperienced Inspectors

Reinforced concrete work needs inspection, but it must be real inspection by experienced and well informed men; work being carried on under inefficient and ignorant inspection is badly handicapped. In this connection, L. C. Wason¹ relates an interesting instance which occurred in his company's practice.

It seems that on a job for the state a transitman was appointed to inspect some granolithic paving. He was thoroughly conscientious and honest, but entirely ignorant of the work he had to inspect, and thoroughly suspicious of the contractor. The cement was delivered on the job in bags, which was a brand new proposition for the inspector. He would not take Mr. Wason's word for it that four bags made a barrel. There were no Portland cement barrels available, as the work was in a rather inaccessible, country place. However, with considerable difficulty he found a natural cement barrel and insisted upon the cement being dumped from the bags into this barrel to be measured. In this loose state it took only three bags to fill the barrel, and he insisted that only three bags should be used in a batch instead of four. Realizing that the work would fail and that there was a five-year guarantee on the work, Mr. Wason insisted on using the four bags. The inspector did not wish it. The difficulty was overcome as follows: There was one longitudinal joint in the work which the inspector learned that his chief desired to have absolutely true and straight. An extra man was put on the job to set up and knock down the curb board for this joint throughout the forenoon, while the inspector was squinting through a transit at the far end to line it up. Meanwhile, the concrete for the day was being mixed and placed from the opposite end of the job. After more than 16 years, the pavement is in perfect condition.

Curtain Wall Efficiency

On the ground of cheapness of construction, it is almost always better to put curtain walls in after the frame is up; the work then goes ahead much faster. Weather-tight joints can readily be made, and the joints between the frame, that is, the columns and floors, can be concealed so that no unsightly crack is visible.

¹Cons. Engr., Ames, Ia.

²Koehring Machine Co., Milwaukee

¹Pres., Aberthaw Const. Co., Boston

Information and Consultation: The How-to-Do-It Department

*This magazine is for service. Let it serve you, and you help it to serve.
You want special information. Ask us. We know the men who know.*

Insurance Regulations Relative to Residence Chimneys

"Is there a specific ruling by the insurance underwriters to the effect that houses with concrete chimneys and terra cotta flue linings are a greater risk and therefore call for a higher rate of insurance on the house in which they are?"

[Editors' Note—The above specific question is quoted from a letter recently received. To explain the question more fully the letter is published in full in the following paragraphs:

As one particularly interested in concrete and its products, I am writing for information regarding insurance regulations relating to chimneys in buildings for residential purposes and would be glad to know whether or not there is a specific ruling by the insurance underwriters to the effect that houses with concrete chimneys and terra cotta flue linings are a greater risk and therefore call for a higher rate of insurance on the house in which they are.

A recent personal experience brought out the fact that this kind of construction in a house, two stories of which were

of solid concrete and the third story of stucco, necessitated a rate of 25c per \$100 higher than if the chimneys had been of brick. I can understand the reasonableness of the objection to a concrete and terra cotta chimney, due to the probable uneven expansion and contraction of the materials, but I will thank you to tell me if you know of any reason why concrete alone should not be accepted on equal terms with brick for chimneys. My own personal judgment would much prefer it to the latter, even to the extent of paying a higher premium, in that when it is cast and once up, the possibilities of any cracks or openings occurring are very remote, while in brick chimneys I consider that it is almost a probability that eventually there will some defect appear whereby the danger of fire will be increased, due to the many joints in laying the brick.

I think that this is a question that will be of increasing importance owing to the rapid spread of concrete for use in constructing smaller buildings, particularly in view of the fact that concrete or the materials that go to make it up are available almost everywhere, and also for the reason as suggested above—that it is a better material.]

communicate directly with his home organization, in order to secure definite information in regard to the subject of rates.

Your correspondent, however, is mistaken in his assumption that concrete chimneys, because a monolith in construction, do not crack. I have had considerable experience with such chimneys in high temperatures, and know that they almost invariably crack, and I am informed by insurance inspectors here that they have frequently considered it necessary to require the repair of concrete chimneys which they have found to be cracked. The tendency of such cracking would undoubtedly be less in a dwelling house chimney than in

a chimney for a factory or similar installation where hot fires were likely to be continuously used. However, there is always the danger of an occasionally sudden, though perhaps temporary, rise of temperature in a dwelling house chimney, and that is the condition which would produce the crack.

For this reason we believe it to be quite necessary that dwelling house chimneys should be lined with terra cotta or fire clay flue lining, and that the outside walls of such chimneys should be not less than 4" thick.

There is a tendency in some parts of the country to use brick on edge and other methods of construction which give a thin chimney wall. These we believe to be very dangerous and we are unalterably opposed to such construction. We also believe that when chimneys are made of concrete they ought to be reinforced in some manner. The additional cost is very slight indeed, and the advantages to be gained are substantial and apparent.

We have just completed a draft of a building ordinance for small towns and villages, which is now being printed, and in this we have specified features of construction which we believe to be important in building chimneys.

Preliminary plans have been made for a \$285,000 viaduct to cross Duck Creek, Cincinnati. There will be 10 60-ft. spans and the viaduct will have a 60-ft. roadway with two 9-ft. sidewalks.

The new building code for Hartford, Conn., offers a very complete and up-to-date section on concrete and reinforced concrete. It requires that an inspector employed by the owner be stationed on all reinforced concrete buildings and report daily to the supervisor. Rail carbon steel may be used.

¹Consulting Engr., Nat'l. Board of Fire Underwriters, N. Y. C.

Washing Crushed Stone

"How can dirty crushed stone intended for reinforced concrete be washed easily, quickly and economically without using a concrete mixer? I have found that to use a mixer for such work is not economical. Probably some of your readers can give me an illustration and description of

a round conical screen that can be turned, preferably by hand, where the crushed stone could be shoveled into the small end by hand and a hose with a strong stream of water held on it. The stone is rolled over and over and comes out of the large end, clean."

DISCUSSED BY J. I. MILLER¹ AND C. W. BOYNTON²

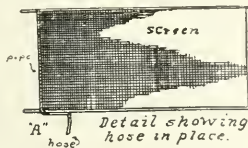
By MR. MILLER

The accompanying sketch shows the equipment which I have used successfully to wash crushed stone while unloading it into wagons from a car. I set a screen from the top of the car to a wagon bed and as the rock passes down the screen a stream of water is played on it from a specially arranged distributing nozzle as shown. This nozzle is placed at the bottom of the screen and parallel to the bottom.

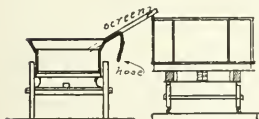
Local conditions govern the construction of this washing equipment. The most important factor is the water pressure available. If the

¹J. I. Miller Construction Co., Wills Point, Tex.

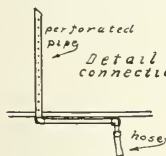
²Engr. in Charge, Information Bureau, Universal Portland Cement Co., Chicago



Detail showing hose in place.



View showing screen and hose in place



Detail of hose connection at A.

SKETCHES SHOWING ARRANGEMENT OF HOME-MADE GRAVEL WASHING EQUIPMENT

water pressure is very high a large screen can very well be used; if, on the other hand, the water pressure is low, a smaller stream would be required. This factor, of course, depends upon the width of the screens only, as any length can be used—in fact, the longer the screen the better results will be had. My experience seems to show that an angle of about 30° from the horizontal is about the best inclination for the screen. At this incline the material will move slowly in front of the flow of water. Any size screen can be used as required for special work, although, generally, three or four openings to the inch are most convenient. The holes bored in the special nozzle are about 3/4" apart, and adapted to the pressure available.

By MR. BOYNTON

At Sebawaing, Mich., a home-made gravel washing plant was erected for the preparation of aggregates to be used for a concrete pavement. In installing this plant for the purpose of washing and screen-

ing sand and gravel as it came from the river, a small centrifugal pump was secured which was driven by means of a 5-h. p. gasoline engine. This pump and engine were set up directly on the bank of a large ditch or river. An ordinary mason's screen was then placed in position alongside of a pile of aggregate where it was deposited as it came from the river. This screen was set at about 45° to the horizontal.

A 1 3/4-in. pipe was laid from the pump to the screen and also from the river to the pump; this pipe ran about 1 1/2' over the top of the screen between two sheets of metal. The purpose of these metal sheets was to spread the steady stream of water as it came from the pipe, into a strong spray. Men with shovels handled the material from the pile onto the screen and as it rolled down over the screen, the spray of water coming from between the two metal sheets washed it. The sand was carried through the screen and the gravel, of course, was retained upon it. It was found that nearly all of the foreign material which, in this case, was mostly clay, was carried away in suspension in the water which ran back into the river.

A \$125,000 reinforced concrete wharf will be built at the U. S. Naval Academy at Annapolis, Md. Concrete substructure will be used on this work, and bids will be received on two types of construction:

(a) Reinforced concrete piles supporting a reinforced concrete superstructure, and (b) reinforced concrete cylinders supported by wooden piles and supporting a reinforced concrete superstructure. The superstructure will consist of reinforced concrete girders, beams and floor slab.



USING A FLAT SPRAY AND A SMALL INCLINED SCREEN TO WASH GRAVEL

How to Clean Concrete from a Mixer

"What is the best way to clean concrete from a mixer? We have run it all the season and want to clean it up before storing away for the winter."

DISCUSSED BY:

J. A. McCARTY¹

F. H. BOLTE²

BY MR. McCARTY

HEATING THE DRUM

Have the engine man use a hammer, pounding lightly. Then use a steel scraper, and lastly, a good steel wire brush.

It is a better plan to keep the mixer clean, and it can be done this way:

One cu. ft. of sharp broken stone should be dumped into the mixer each noon and night, along with clean water. The mixer should run, say 5 min., then stone should be dumped out into a box that is equipped with handles, and has plenty of $\frac{1}{2}$ " holes in the bottom to let the water out. The box can be set aside and the stone will be right there on the job for next cleaning. A mixer that is kept clean will scour very bright in a short time. A brick made of carborundum³ can be obtained. These bricks easily clean concrete from the sidewalk.

If the mixer is equipped with steam power, the engine should be well covered before laying up for the winter. First, back off all stuffing box nuts from piston and valve rods, paint all bright parts with a dope made of equal parts of white lead and tallow. Remove all packing from piston valve rod glands, wipe rods dry and oil. Do not put in new packing until spring. Wet packing makes rings of rust on the rods and piston, and makes them leak. Clean boiler well, blowing off hot, and removing all hand-hole plates. Cover the top of the boiler with tar paper and canvas. If the mixer is in need of any new parts, order these parts at once and have them installed on mixer. If gasoline power is used, treat all piston and valve rod glands in the same way as the steam engine is treated. Get all equipment under cover in a dry place.

BY MR. BOLTE

In cleaning our mixer, which is a continuous mixer, using a rotating cylinder, we have found the following methods very useful:

Disconnect the drum, place cover over one end and start a brisk fire inside, being careful not to have same too hot. Then as the drum becomes heated, strike the drum repeatedly on all sides. This process, in our experience, has always proved very successful.

Cinder Foundation in Sidewalk Construction

"We should be glad to hear from authoritative sources some expressions of opinion relative to comparative merits of concrete sidewalks with and without drainage foundation, using as a basis for comparison a 4-in. thick slab of concrete laid on a cinder cushion 8" in thickness, or a 4-in. thick slab of concrete laid on a solid dirt bottom, without any cinders or other provision for drainage. Our own experience has been that the latter method is equally as good as the former, if not a shade better, other things being equal as to material and workmanship, but we should like some expressions from engineers and others in the trade as to which of the methods, if any, is either considered standard, or tending to become so."

"In this connection, we should like to know whether or not it is usual in the case of the cinder foundation being required, to demand that the cinders be passed through a $\frac{1}{4}$ -in. screen, assuming that the cinders are a good grade of factory cinders, with the usual amount of fine material, but free from waste or rubbish. We have been in the habit of using the cinders as they come to us, but we are now asked to screen them through a $\frac{1}{4}$ -in. screen, on the engineer's interpretation of the clause 'clean steam cinders' used in the specifications."

"Is the specification referred to not unusually strict, and arbitrary in general, and if required to be lived up to in its entirety, would it not make the cost of sidewalks laid in strict conformity with it a very expensive, not to say an almost prohibitive, job?"

"I want to get some idea of the comparative cost of reinforced concrete and so-called rubble concrete construction for dams. I would like to get some notes on the advantage of each type of construction and also the cost per cu. yd. and suggestions as to the method of handling."

"The specific case I have under consideration is the construction of a dam in a fairly accessible locality. There is considerable loose rock in the neighborhood and many large boulders. Sand would have to be hauled quite a distance and the cement would have to be hauled about 4 miles."

DISCUSSED BY O. L. CHIGLER¹

I have followed with much interest the discussions on sidewalk work, and being a cement worker, I would like to add another experience to those already given.

As my father was in the cement business before I took up the work, I had a chance to get quite a bit of experience that was already his, and have since studied it in different states and also the larger cities.

CINDER BASE

In our opinion it is best to use a cinder base in this locality; although it is not used here, not because the cinders are not available, but because our customers desire a much cheaper walk, and use as their argument the statement that cinders are unnecessary.

We used cinders for eight years with wonderful success, but at last, to meet the prices of our competitors, we were forced to lay walks directly upon the ground.

In different localities opinions differ, but we have laid walks in this section of Missouri enough to know that it is impossible to lay a walk in the mid-summer and make a first-class job of it without using cinders or gravel as a sub-base. We laid our first walk on the ground in the fall of 1905; we made a 50-ft. walk, 2' wide at this time for one of our customers, as an experiment. This proved successful and since that time the demand has steadily increased until there are no more cinder base walks laid. However, here I would like to state that the walks of today are not giving the satisfaction that the earlier walks gave.

Cinders are cheap in this section, as we have several brick plants from which to get the cinders. Our customers claimed that cinders decomposed in the water, but after replac-

¹Detroit

²Girbau Mfg. Co., Eau Claire, Wis.

³Carborundum Co., Niagara Falls, N. Y.

¹Crigler & Dunlap, Vandalia, Mo.

ing several walks (poorly laid) we find the cinders in an excellent condition. We used a class of cinders that came to us direct from the kilns and contained considerable fine dust. Cinder trenches give enough earth to make the proper fill around walks, are easily graded, and furnish a covering to the soil to keep it from drying the under surface of the walks, providing that the cinders are well wet as they are tamped.

Too much stress cannot be laid upon the word "wet," as moisture is the one great thing for walk work. A walk is like a concrete block, it must have plenty of water when the sun is drying it.

We are now building the most nearly perfect walk we have ever made. This we have decided is the

best. We use common 2-in. x 4-in. forms well staked, using templates every 6'. For the bottom we used a 1:7 mix surfaced with a $\frac{1}{2}$ -in. topping, mixed 1:1 $\frac{1}{2}$. The topping is placed immediately after the bottom has been placed, finished and brushed very lightly. The dividing plates are removed immediately following the finishing.

We are positive that the time will come when we shall see no more of the two-course walks, and we are in favor of the one-course walks as they will give more satisfaction than the walks do today. The template, or dividing plate, is in our estimation the best way to make a cut joint walk as the grout knife and the spear invariably causes the corners to break and spoils a nice piece of work.

of 11 das. only 80 cc. of oil were left, showing a loss of 68% of the oil, part of which was no doubt due to evaporation.

For the first day or two the glue coating appeared to remain fairly insoluble in the oil, but at the end of the experiment it was soft and sticky. To overcome this defect, it was determined to find out whether or not gelatin, when treated with a solution of potassium bichromate, became insoluble in oil. Mold No. 3 was therefore painted with a solution consisting of gelatin, 10 gms.; potassium bichromate, 20 gms.; and water, 200 cc., but after two days most of the oil had found its way out through this coating.

No. 4 mold was painted with the same thin glue solution as that used in the case of No. 2; but, before the glue had quite set, it was painted over with a 5% solution of potassium bichromate. As before, 250 cc. of oil were poured in, and after 10 das. there was only a loss of 50 cc., or 20%, which was due entirely to evaporation, as there was no evidence of percolation, and the glue coating was as hard as it was before the oil was poured in.

It would seem possible, then, at very little extra cost, not only to construct reservoirs of concrete which will retain petroleum by painting the interior with glue and a 5% potassium bichromate solution, but also to line the interior of iron tanks with a thin coating of cement treated in the same way.

Unfortunately, lack of time prevented the writer from carrying out experiments on the same lines with the heavier oils, or crude petroleum; but it would appear that no greater difficulties would exist in their case than in that of the more volatile kerosene used in the experiments described.

Storage Tanks for Oil

"Can concrete be used to build tanks for storing oils, both vegetable and mineral?"

EDITORIAL DISCUSSION *

In a paper read before the South Staffordshire and Warwickshire Institute of Mining Engineers of which abstracts were published in a recent issue of *Concrete and Constructional Engineering*, J. L. Jeffery, A. R. S. M., M. Inst. of M. M., etc., states that the construction of reservoirs for petroleum, especially for the lighter distillates, presents a rather serious problem, because concrete which may be perfectly watertight will allow petroleum to percolate through it very readily. With regard to ordinary kerosene, the storage of which in bulk is of the greatest commercial importance, there is the additional disadvantage that it is also a solvent of most ordinary paints, and corrodes iron to a great extent.

For these reasons engineers have found that refined petroleum cannot be satisfactorily stored in steel or iron tanks, as it works its way out between the rivets and the rivet-holes, and paint is worse than useless for preventing this. If a cement-concrete could be found which was oil-

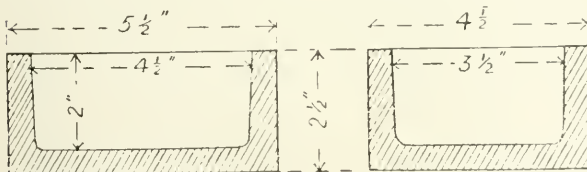
proof as well as waterproof, then the problem of storing petroleum in both iron and concrete reservoirs would be solved.

It was with this view, therefore, that the author tried a few experiments with small concrete tanks (or molds) of the dimensions given in the accompanying sketch, and made of a 1:2 mixture using cement and sand. The watertightness of the molds was tested in every case.

No further treatment was pursued in the case of No. 1 mold, and 250 cc. of kerosene were poured into it and covered with a glass plate. Within 24 hrs. the oil had entirely percolated through.

THE USE OF GLUE COATINGS

No. 2 mold was coated inside and out with a thin glue solution, and the same quantity of kerosene was poured into it and allowed to remain for several days. For the first day or two the mold appeared to be oil-proof; after this period a slight percolation took place, and at the end



LONGITUDINAL AND TRANSVERSE SECTIONS OF CONCRETE TEST MOLD USED

February, 1914

Failure of a Sidewalk Surface

"Some time ago we put down a 10-ft. sidewalk in front of a business house. We used a 1:2 mixture for the top coat; the surface was well troweled and looked like a first-class job. About two weeks after it was opened for traffic, however, the surface began to scale and peel off.

"What we want to know is this: Is there a coating of some kind that could be applied over this top (which is rough) that will give it a smooth, hard finish that will wear well and give good service? The walk is covered by an awning its entire

length, so that there will be but little water on it, if any."

DISCUSSED BY IGN. BILODEAU¹

In my opinion there is no danger of checking in a sidewalk finish if the mix is not made richer than 1:2 or if the material is not mixed too wet. To eliminate checking, the surface should also be well covered so that it will not set or dry out too quickly. The wind will hurt a concrete surface as much as the sun and I believe much of the trouble comes from this.

I shall always be of the opinion, moreover, that if we could (I mean if our clients or engineers would let us) always finish our work with a wood or a cork float all this trouble would be ended. Some critics of this later method may say that when a concrete sidewalk is finished under a wood or a cork float the surface is not so hard. This, however, is true for the first few months only. After the first few months' wear the sidewalk finished with a wood float will be as hard as any other. According to my experience, when a sidewalk is troweled very much all the cement is brought to the top, while with a wood float the good hard sand is held at the upper surface. I shall be glad to have further opinion on this.

cost of operating 10 salamanders would be about \$4 or \$5 a day.

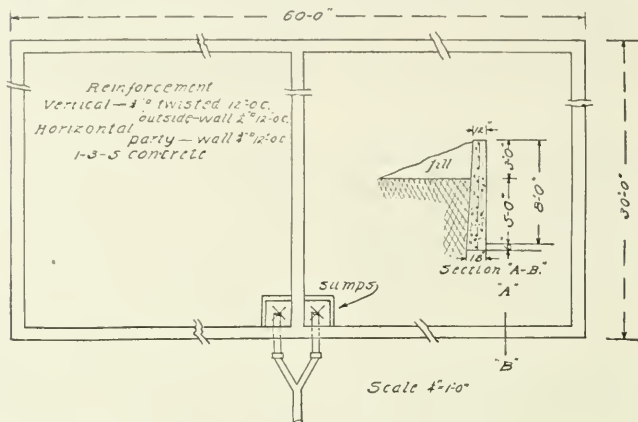
Salamanders should not be set

directly on a cement finished floor as the gases will ruin the cement finish.

Expansion Cracks in Reservoir Construction

"The accompanying sketch shows a reservoir which we have now in plan. We want to know what would be the best scheme of taking care of expansion and contraction in the

walls and floor. Practically all of the walls and floor will be underground after completion, but we do not want to take any chances on having cracks develop."



SUGGESTED PLAN AND WALL DETAIL FOR RESERVOIR CONSTRUCTION

Cost of Operating Salamanders

"Can you tell us how much it costs to operate salamanders when running concrete work in cold weather? This question naturally resolves itself into the size of the salamander, the price of the fuel, and the amount the salamander is crowded for heat. We shall appreciate some first-hand information on this."

DISCUSSED BY F. W. KEYSER²

The cost of operating salamanders depends much upon how the building is located. For a large one-story factory, about 200' x 60', with few partitions and where the window openings were covered with cheesecloth (windows did not arrive in time), I used 10 salamanders. The cost of coke was about 10 cts. a bu. and it required the attention of one man to take care of them and fill them at night. I should say the

DISCUSSED BY FRANK C. THIESSEN³

The vertical walls of rectangular reservoirs which make use of a portion of the excavated material for backing to the walls should be strong enough to resist the earth pressure when the reservoir is empty and also to resist the water pressure, neglecting the earth fill against the wall unless this material is sand or other material of non-cohesive character.

The amount of steel necessary to prevent large cracks will depend principally upon the exposure and thickness of wall. Ordinarily from 0.2 of 1% to 0.4 of 1% is used. Where the temperature variation is not large and other conditions are very favorable, as little as 0.1 of 1% may be sufficient. On the other hand, very thin walls in exposed or unfavorable conditions may require more than 0.4 of 1%. The sizes of rods most commonly used for temperature reinforcement are the smaller sizes, usually 1/2-in. and 3/4-in. rods. The steel should be placed not more than 2" from the exposed surfaces.

Concrete Floors in Soap Factories

"Do the fats and alkalis used in manufacturing soap have any effect on concrete wearing surfaces?"

EDITORIAL DISCUSSION

In the Union Stock Yards, Chicago, practically 90% of all recent construction and reconstruction has been of reinforced concrete, and, almost without exception, this work has given complete satisfaction. In a recent issue of the *Engineering Record*, J. Norman Tensen, of the Chicago Building Dept., describes a failure of a finished floor in one of the buildings used for refining lard. The floor in this room has been pitted from 1/4" to 1/2" in some places. This floor contained large kettles in which hog fat was boiled. Occasionally these kettles boiled over and some of the hot lard spilled on the floor. Wherever the hot lard came in contact with the finished concrete it ate a hole in the floor. This pitting was not caused by wear, as this

¹Paving Contractor, Quebec, P. Q.

²Estimator, Sperry Engrg. Co., New Haven, Conn.

³Inst. of Struct. Engrg., Univ. of Wis., Madison, Wis.

was practically no trucking on the floor. Although the finished floor was less than one year old, it had to be replaced by a brick floor. This brick was of special make, only $1\frac{1}{4}$ " thick. The joints were filled with cement mortar. What precautions can be taken to prevent this action of the hot lard?

Concrete Pavement Surface on Grades

"We purpose putting in concrete pavements on some streets where there are grades exceeding 6%. What is the best treatment for the surface of the concrete on such grades with reference to foothold and to wearing qualities?"

DISCUSSED BY:
LOGAN WALLER PAGE¹
A. N. JOHNSON²

BY MR. PAGE

I should not adopt concrete for a grade exceeding 5%, and attempt to make it serviceable by any treatment of the surface. Any design requiring markings on the surface sufficiently deep to give foot-hold will in time spall, and as soon as this occurs, the irregularity and unevenness of the surface are almost certain to increase rapidly under traffic, and in case of concrete construction, this means rapid deterioration or possible failure of the road.

BY MR. JOHNSON

It is my present inclination to feel that such a pavement is limited to grades of 6%, although it might be employed on grades of 7% for short distances.

Other than to be sure that the pebbles composing the aggregate are of the hardest character and the concrete thoroughly mixed and an abundance of cement used, I do not know that any special device is of particular value in constructing the concrete pavement surface on a grade as distinguished from one laid on a level stretch, except perhaps after the pavement has been wood floated, it should be marked with a broom crosswise of the road.

Our experience, however, with concrete pavements is not extended enough to state definitely what limitations it has on steeper grades, but from analogy, it is safe to say that it can be used on grades 1% or 2% steeper than sheet asphalt.

¹Director, U. S. Office of Public Roads, Washington, D. C.

²State Highway Engineer, Springfield, Ill.

Construction and Layout of Steam Rooms in Products Manufacture

"We are building a new plant for the manufacture of concrete products and would like information as to steam room construction: walls,

roof, pipes and best size for the rooms. We shall make concrete block, architectural stone and fence posts."

DISCUSSED BY J. W. ROSS¹ AND H. A. COLLINS²

BY MR. ROSS

We have a gutter in the floor along one edge of the steam room with a perforated steam pipe in it. There is a water pipe at one end which keeps this gutter full of water when we are steaming, so that the steam is deposited into the water, ensuring a supply of moist steam which keeps the block dripping wet all through the process of curing.

As to the best construction for walls of the kiln and roof, our walls are made of concrete, also the ceiling, which is arched so that the condensed steam on the ceiling will follow down the walls and not drip from the ceiling onto the new block. The floor is laid with a little slope towards the gutter, so that all the water from the condensed steam will drain into the gutter.

Our piping system is so arranged that we can steam in one room at any time or all rooms at the same time if we so desire. The size of these kilns should depend altogether upon the number of block manufactured each day, each kiln holding one day's run.

BY MR. COLLINS

We are using five steam rooms 60' long with three tracks in each. The walls are of block construction, ceiling of reinforced concrete in arch form, trowel finish to allow the condensed steam to draw to either side, with a sewer connection in the center to carry this off. The outlet doors are of sheet steel, asbestos lined; for the inlet doors we are simply using a roller curtain of very heavy duck with side clasps. We use a 2-in. supply pipe from our boiler and an individual set of valves for each room permits the turning on of all the steam in each room separately.

Painting Block and Tile Cars in Products Plants

"I have trouble finding a paint covering for block and tile cars used in steam kilns which will resist the heating, drying and wetting to which they are subjected. What paint will give satisfaction?"

DISCUSSED BY
CHARLES E. SIMS¹
P. E. McALLISTER²
H. A. COLLINS³

BY MR. SIMS

I have experienced no difficulty in regard to the durability of paint in the curing rooms where ordinary care has been taken to use it properly. A paint intended to be used on wood together with the precaution of cleaning the surfaces that are to receive the paint constitute all the attention that I have found necessary to give to this subject. For the preservation of the roof joist and boards one coat of prepared paint sold as a waterproofing for concrete surfaces has kept our factory roof in good condition through the past four years—the surface being thoroughly dry when painted and thoroughly wet ever since from the condensation of the steam used in curing our products.

BY MR. McALLISTER

For the last two years we have been going over our block cars with a coat of black iron paint⁴, and have had very good success with it.

BY MR. COLLINS

With reference to paint for use on

¹Worthington Concrete Tile Co., Worthington, Minn.

²Anna Dean Farm, Barberton, O.

³Standard Concrete Products Co., Louisville, Ky.

⁴Purchased from the Akron Varnish Co., Akron, O.

cars in curing rooms, we are using a red lead and boiled linseed oil, which, in our opinion, is giving first-class satisfaction.

Placing Concrete Under Water

"In discussing some work under plan now the following questions have come up:

"1. Is it necessary to follow any specific methods in placing concrete under water?

"2. In order to keep down the amount of water is it detrimental thoroughly to mix the ingredients dry and place them without adding water?

"3. Is it detrimental to place concrete as above in water which would contain $\frac{1}{4}$ part of sulphuric acid in various forms, together with petroleum oils?"

DISCUSSED BY CLOYD M. CHAPMAN¹

A most excellent authority on this subject is Olaf Hoff, who did such a remarkable job of placing concrete under water in building the Detroit River tunnel. Briefly, answer to the three questions may be made as follows:

1. It is very necessary to follow carefully specific methods in placing concrete under water.

2. Water should always be mixed with concrete in a definite manner, not allowed to soak as it may into the dry material. Concrete to be placed under water should be thoroughly mixed before placing but should not be any wetter than is necessary for handling.

3. It would undoubtedly be detrimental to place concrete as described in the question but by the tunnel method used in the Detroit River tunnel concrete can be placed in almost any water and be damaged at the surface and outside only. That is, the great bulk of the concrete would be perfectly sound and free from contamination by the water or oil. The method used at Detroit is fully described in Mr. Hoff's paper read for the cement users convention² in Chicago in Feb., 1910.

A. Reiche, formerly Gen. Mgr. of the Orenstein-Arthur Koppel Co., Koppel, Pa., has been succeeded by Erich Joseph, formerly New York manager of the company.

Detail Data on Concrete Bridges

"Is there available information on the design and construction of the principal concrete bridges covering the lengths of each span and rise, width of roadway and sidewalks, yards of concrete in substructure and superstructure and with steel in tons or pounds, mixture of concrete, cost per cu. yd., total cost of structure, etc.?"

DISCUSSED BY DANIEL B. LUTEN¹

In regard to yardage and dimensions of various arch bridges, I think this inquiry would require far too much detail work for any one engineer to undertake. It would be a matter of only 15 minutes' time to state the yardage on any span up to 100', according to our particular methods of design. But it would be found that the yardage would vary, in some cases 100%, between the designs of two different engineers. And for spans exceeding 100' the yardage could be made to vary greatly, depending upon the type of bridge suited to the location. This inquiry is entirely too broad for a satisfactory answer.

If the structures could be limited to some particular spans of moderate length, we should be glad to supply the information. The cost of bridge work varies so greatly that it can be estimated only for known conditions as to location. I have data showing the cost per cu. yd. of hundreds of concrete bridges, but they would be of no value to any one who did not understand the exact conditions under which to apply them. In general, concrete bridges will vary in cost from \$5 to \$25 per cu. yd. of concrete.

Width of Joint in Concrete Paving

"We have recently heard a lecture on the expansion and contraction of concrete due to moisture. Data presented in this lecture seem to indicate that concrete shows a constantly increasing volume through a life of 20 yrs. The definite statement was made that the expansion plates on certain concrete roads are slowly closing together and that they ul-

timately will come in contact and trouble will be caused. What information can you give us?"

DISCUSSED BY JOHN J. COX¹

It is evident that the expansion plates on the Wayne county concrete highways are very close together, so close that on a great number of joints it is hard to tell just how thick the asphaltic felt between the plates is. In making an inspection of these roads the first part of Sept., 1913, together with Frank Rogers, state highway commr. of Michigan, it was so evident that we discussed the subject several times in the course of the inspection and we were firmly convinced that not enough space had been allowed for expansion in these pavements. As to the causes and to the statement that "the expansion plates are slowly closing together and ultimately will come in contact and trouble will be caused," I cannot say. It is only evident to me that enough space has not been allowed between the plates to take care of the expansion.

Preventing Broken Gauge Glasses

We recently received a question about as follows:

How do you make your engineer or mixer man remember to drain the gauge glass on the boiler before he leaves the engine at night when running in cold weather?

Following our usual practice we put this question up to some of the builders in the field who have first-hand experience in such matters. One of the replies that have come in was indicative of real practice along this line. Our contractor friend asserted very emphatically that any engineer who forgot to drain his gauge at night ought to be fired. We omit the detail way in which our friend said the engineer should be fired.

This is all right if engineers are plentiful, but sometimes they are not, and what our inquirer wanted to know was whether or not there was any field "kink" which might be used as a reminder to help out the man responsible for the care of the engine. We should like to hear more on this question.

¹Engr. of Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

²Convention of the Nat'l Assn. of Cement Users, now the Am. Concrete Institute

¹Designing and Consulting Engr., Indianapolis, Ind.

²By Prof. A. H. White, Chemical Engr., Dept., University of Mich., Ann Arbor, Mich.

¹Instructor, Highway Engr., University of Mich., Ann Arbor, Mich.

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Green Concrete in Place Moved in Mass Without Apparent Damage

A LETTER FROM CHAS. H. NEAL¹

Last summer I had an experience in constructing a concrete bridge which is perhaps interesting enough to write about. It may not be an unusual experience, and yet I do not remember to have read of anything just like it. Furthermore, from some cause, some features of it have proven to be contrary to many theories concerning concrete construction, and are moreover considerably favorable to concrete as a building material.

The bridge in question was begun in the latter part of July, 1913. It has a span of nearly 20', with a 30-ft. roadway. The floor is of the slab and beam type, the slab being 6" thick and the beams 24" deep (including the slab), and from 12" to 16" in thickness. The reason for this variation in thickness was that the bridge had to be built in two sections in order to take care of the traffic during construction, the 16-in. beam being at the center of the roadway where the joint in the floor was made. The 12-in. beams were at the sides and formed a part of the parapet walls or wheel guards. The beams were spaced about 5' o. c., making the slabs about 4' wide. The slab was reinforced with 1/2-in. rods spaced 5" longitudinally and 12" transversely. The beams were reinforced with 3/4-in. rods, six to seven to the beam, two or three being bent up in the usual way to take care of the shear. Also stirrups, made of

3/8-in. rods, were used in the beams, spaced 12" apart.

The story is this: We began placing the concrete in the forms of the first section early one morning, using a 1:2:4 mix of cement, sand and crushed stone. About 2 p. m., just before we finished filling the forms, a heavy rain fell, causing the creek to rise suddenly and wash out nearly all the props from under the forms. There being nothing much left but the stiffness of the forms to support the load, the whole structure dropped 3" or 4" in the center.

When the rain ceased so that we could return to the place it was a disheartening scene that greeted us. Below was a yellow torrent of water carrying away props with a crashing noise and letting the heavy mass of concrete slowly sag, while on top were constantly widening cracks in the slab.

I decided that, according to the principles governing concrete construction, the whole thing was a complete loss, and ordered the men to take their picks and shovels, dig it out and throw it into the creek. Not being technical men, they thought this too bad and insisted that we try some way to save it. Supposing that the older concrete had taken its initial set and that in the movement had stripped the rods, I told them it was no use. Someone said there was a jack near by which the street car trackmen had been using and if



A CONCRETE HIGHWAY BRIDGE NEAR ASHEVILLE, N. C.

While the concrete was being poured, a freshet washed out some of the falsework and the concrete sagged. The work was jacked back into place and completed with no apparent permanent damage. Highway Engr. Neal is standing in the foreground

¹Highway Engr., Buncombe Co., Asheville, N. C.

I said so they would get it and jack the mass back in place again.

I finally thought, since we had gone that far with it, we could not lose much more and consented to it. As soon as the water fell sufficiently for us to get under the bridge we went to work and within an hour or two had the forms back in place with new shores under them.

We made a thin grout of cement and water and poured into all the cracks in the slabs, nearly all of which closed when the mass went back into place. We then finished filling the forms and the section was left to stand the proper length of time before stripping the forms.

I did not think that when the props were taken out and the forms taken off it would stand its own weight, since there was no way of telling just what action the concrete had taken relative to the reinforcement. I found, however, that quite a number of shear cracks had developed at the ends of the beams and some small cracks on the under side of the slabs. These were all marked so that I could tell if any new cracks developed under traffic. At first

heavy props were left under the beams so as not to endanger the traffic while making a test of their strength. Gradually these were taken out and the entire traffic of the road turned on while the other half was being constructed.

Since then not a single new crack has shown up. The bridge, being in a suburb of the city of Asheville, N. C., is subjected to a very heavy traffic and was designed to that end. And now, six months after completion, it stands as solid and substantial looking as one could desire.

I am at a loss to know, in view of all that has been said of the unreliability of concrete, why it has done so well and how long we may expect it to continue. I have thought that maybe the heavy reinforcement has caused it to hold in spite of the faulty concrete, or that, perhaps, the mass was soft enough at the time of the washout to let the rods and concrete bend together without stripping. If anybody has had a similar experience and can give any light on the subject I would be glad if he would describe it in the columns of CONCRETE-CEMENT AGE.

has been down now more than 10 years and it has not a crack in it and looks as well as the first class work in front that was guaranteed for five years.

A reinforced concrete floor can be designed to carry a certain load and if there were no defects in the material and construction, or it is not over-loaded, it would apparently seem as good as one in which a factor of safety of four or five was figured. Thus cinders can be considered a factor of safety in the construction of sidewalks.

Construction, Organization, Administration

A LETTER FROM HAROLD FERGUSON¹

Our attention has been called to an article² on construction administration methods by a German engineering contractor, published in the Dec., 1913, issue of CONCRETE-CEMENT AGE. Our own experience has led us to believe that there is no branch of building construction which places so much emphasis on honest building methods as does reinforced concrete. Any "saving" of cement is not only stealing, it is positively dangerous. To avoid absolutely any possibility of poor concrete work we have concluded that the best way is to do all reinforced concrete work upon a strictly cost basis, being paid for our labor and material, plus a percentage or fixed sum for overhead operating expenses and profit.

This plan has worked out so well that we have gradually incorporated this idea into our whole business, until now our operations, ranging from Oakland, Cal., to Providence, R. I., and Medicine Hat and St. Louis, are carried on the basis of time and material, plus a percentage or fixed sum.

As the German engineer suggests in the article previously mentioned, the dangers of competition are very real and are not confined to Germany alone. We much prefer to compete on quality of the sort required by the owner, rather than to gamble on price, with the possibility of loss to both sides.

We do not quite agree with his opinion on sub-contracts. We have few sub-contracts at any time. In general, in sub-contracting, the own-

Cinders Under Concrete Roadways

A LETTER FROM S. W. HOFFMAN¹

E. P. Etzel asks in your Dec., 1913, issue: "Why are modern concrete roadways not protected with cinders, as are sidewalks?" Roadways are not subject to nearly so severe sub-freezing as are sidewalks, as they are usually protected on either side by from 16-in. to 24-in. curbing and even 30", necessitating that the frost penetrate the soil from 4 to 6 times deeper before it freezes under the slabs, and by that time it has very little damaging effect. On the other hand, it has hardly 4" depth until it freezes under the sidewalk slab.

If either were affected by surface freezing the roadway would have the advantage of the sidewalk, it being much thicker. But neither is affected that way, only by contraction, and proper expansion joints will prevent damage resulting from this.

Why use cinders? Because it has been demonstrated by practical experience that they are the best material available, that will not freeze on account of their porosity and still maintain sufficient solidity.

On most country roads of modern

concrete construction, the curbs at the sides are omitted for economy as are also the cinders. The cost of procuring cinders in the country would be prohibitive and the large supply necessary would be unavailable. But the roadway generally has 2" advantage over sidewalks in thickness and the ground grades away from either side, preventing the moisture from penetrating to any great extent, thus insuring a dry freeze, which consequently is not very severe on the concrete.

If conditions should be such that the roadway were forced up by a severe freeze, and the concrete were not strong enough to bridge across, longitudinal cracks might appear, as is noticed sometimes. Checks and cracks do not look nearly so bad as in a nice finished sidewalk. Hence cinders are more necessary under sidewalks, and when they are omitted it is to reduce the cost.

Frequently sidewalks remain perfect when laid on the ground without any foundation. I can recall one instance in which I laid a cheap walk in the back yard of a residence. The ground was just leveled off and the concrete was only 2 1/2" thick, being placed directly on the ground. It

¹General Contractor, Zanesville, O.

¹Samuel Austin & Son Co., Cleveland

²"Contracting Economics and Administration," p. 257, Dec., 1913, issue

er pays a profit to both the sub-contractor and general contractor, and our slogan of "One organization and one profit" is proving very attractive to owners who have become disgusted with sub-contracting methods, because of delay and increased expense and lack of co-operation.

I see no reason why reinforced concrete work should be conducted by an entirely separate and highly specialized organization, as he suggests, when it can be conducted with equal attention by a distinct and highly specialized department of a large building company.

The development of engineers along executive lines is providing us with administrative talent for large building organizations which embody not only real executive ability but unusual technical knowledge and ex-

perience as well, and in consequence, we feel that with an efficient organization the departmental scheme of specialists co-operating in one organization is best.

Our company has gone a step further and we believe that there is no one who can design a building quite so well as a designing organization with definite responsibility, co-operating with a construction department which is handling large work all the time. Similarly we believe that no construction department is quite so efficient and far-sighted as one which is in very close touch with the designing organization which provides plans for its work.

It hardly seems to me that America needs to wait on Germany for examples of improved construction methods.

posts and planks being cast as separate units in the required quantities and shipped right to the job.

They may be erected very rapidly, as after the post holes have been bored and the posts erected, the planks are simply dropped into place down the slots and no time is lost sawing off and nailing, etc., as with a wooden fence.

Another feature is its portability, as if it is desired to remove the fence elsewhere, it is only necessary to lift the planks out of the slots and pull up the posts, without any damage being done, and the fence is as good as new for being erected again.

Only two sets of molds are required, one for the posts and one for the planks, which considerably reduces the initial cost of the fence.

The sketches merely show a plain post and rail fence, but for factory and estate enclosures, etc., where perhaps a better appearance is desired, the planks may very readily be embellished with a few ornamental features without much alteration in the molds.

Construction of Concrete Fence in Easily Portable Units

A LETTER FROM JOHN A. DICKINSON¹

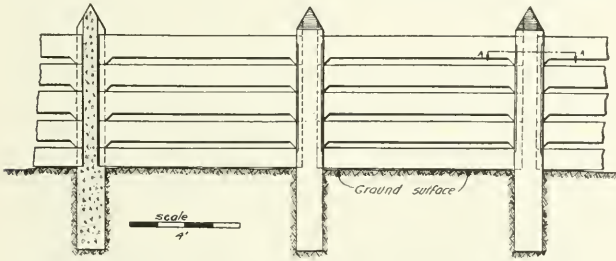


FIG. 1—SECTION THROUGH POST AT LEFT AND ELEVATION OF FENCE

The accompanying sketches give a suggestion for a portable reinforced concrete fence made in two separate units for erection in place.

The posts are of rectangular section, provided with slots extending down to the ground line on two opposite sides; into these slots the rails or planks are placed. The posts are reinforced vertically with No. 18-ga. bars in each corner and the planks are reinforced with No. 18-ga. expanded metal, 3-in. diamond mesh.

The planks are cast in single lengths with lugs or distance pieces under either end, so as to provide a space between the rails. Other details will be clear from the drawing.

The main advantages of this type of fence are its simplicity of construction and ease of erection, the

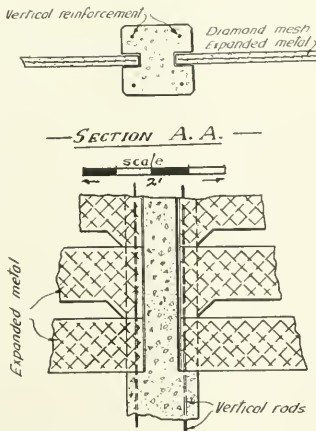


FIG. 2—SECTION VIEW SHOWING REINFORCEMENT OF PARTS

Who Pays the Quantity Surveyor?

A LETTER FROM LESLIE H. ALLEN¹

In your note in the Nov., 1918, issue on quantity surveying you mention the method of payment for quantities which is still in effect in England. This looks absurd in American eyes and yet there is a good reason for its being established, although I think the reason will not appeal to us on this side, and when quantities get to be a regular thing in America, payment will always be made by the owner.

The science of quantity surveying has been in existence in England for about 50 years only and originated by builders who were asked to tender on a building, meeting and appointing one from among their number to prepare their quantities and furnish each with a copy, unpriced, on which he would make up his bid.

In order to reduce unproductive expense, there was an agreement among these parties that whoever got the job should pay the whole cost of preparing the quantity schedule, and so each builder added the cost to his bid before putting in his tender, and the owner unknowingly paid for the quantities. In event of the bids all being rejected,

¹St. Catharines, Ont.

¹Boston

the competing builders each paid a proportion of the cost.

Very soon independent surveyors took up this work, thus insuring an impartial schedule of quantities. Before long, architects realized the advantages to them in having the appointment of this surveyor in their own hands and in having the use of the quantities during the progress of the building and for the settlement of extras, so that it was not long before the quantity surveyor came to be appointed by the architect instead of being appointed by the competing builders. In many cases this was done without the owner's knowledge and the cost continued to be added to the bid and paid by the builders. The owner was thus no worse off than he had been when the builders appointed and paid the surveyor without the architect's knowledge.

Before long there began to be trouble about jobs which were estimated on and not carried out. In the first case of this sort the quantity surveyor started to sue the lowest bidder and lost his case. He then sued the architect and was directed

by the court that his suit should lie against the owner, and although it took several cases to establish the point finally, it came to be the common law of the country that it was necessary to take out quantities in order to obtain competitive bids and that the owner was liable for the surveyor's fees if the building was not built. The law as it stands is that when an owner instructs an architect to get bids, this implies an authority to engage a quantity surveyor for the work, and the owner is liable for his fees. The custom has still remained of adding the surveyor's fees to the builder's tender, but it is a matter of common knowledge to building owners that quantity surveyors are employed and that they are indirectly paying their fees.

Some people in this country who are interesting themselves in this subject have confused this question of payment with the subject of guaranteeing the accuracy of the quantities. There is, however, no connection between the two matters and the fact that the builder pays the surveyor's fees does not constitute any contract between them nor of itself imply any liability for errors.

ed by the multitude of high-class industrial and mercantile structures stretching across the continent from one end to the other, wherein the two materials have been combined attractively—concrete for foundations, columns, beams and lintels, and brick for curtain and interior walls and in many instances for pier and lintel facings as well. Buildings of this kind are, in fact, much more numerous than those wherein concrete is used entirely to the exclusion of brick.

That structural steel is sometimes used for the framework of structures with floors and foundations of concrete, is nothing against concrete. In many instances the use of steel represents ultra-conservatism and means an unwarranted extra cost; in others it is a device to carry extraordinary loads while keeping down the size of beams; and in the case of buildings over four or five stories, the use of structural steel cores to keep down the girth of columns is both common and justified.

The writer in *Brick* describes as his ideal of safe construction a building with columns of steel encased in brick. Now no one disputes that brick properly laid up in cement mortar and the space between the brick and the metal well slushed with the same, makes a very satisfactory protection. But note the use of cement, which is hardly less than a concrete casing of equal protective value would require. If an owner prefers brick casing for his columns, no one, not even the cement manufacturers, will dispute with him. But if he also wants a thoroughly fireproof floor, he will have his building experts lined up solidly against him if he insists on steel floor beams, fireproofed with brick. He will be told plainly it is impracticable. And for the same reason brick is very rarely used for fireproofing columns. The writer in *Brick* was lucky in finding a single instance to serve his distorted purpose.

Figures are also twisted and juggled in the article in question, to show that with brick bearing walls and brick arches over windows, it is possible to have a larger percentage of the wall area windows, than when concrete wall columns and lintels are used. But his figures, which he states show this, somehow fail to bear him out, and prove instead the contrary. In straining to make a point here, he has overbalanced himself and toppled over completely, it would seem. If there is one place in which concrete construction has unquestioned advantage, it is in affording the maximum wall lighting area.

Relative Values in Safe Factory Construction

A LETTER FROM HARRY FRANKLIN PORTER¹

In a recent article published in a contemporary² devoted to brick and clay development, a special feature article discusses "Safe Factory Construction." This article, while discussing under a thinly disguised impartiality various types of construction, really resolves itself into an attack on concrete. If the author had started out with a clear definition of what he understands a concrete building to be as opposed to one of brick, we could bear with him better. But after damning concrete as a building material uphill and downhill, he proceeds to give some examples of safe construction, and with one exception these all have reinforced concrete floors, hence really should be classed as concrete structures. If, then, concrete is so eminently satisfactory for floors, what is it that unfits the material for walls, etc.?

Of course, concrete is the only structural material for factory floors—even the most prejudiced proponents of the brick and clay interests have to admit that. And if safe for

this, it must be safe for all purposes. If in cases brick has been given preference for walls, it is not for the reason the writer in *Brick* would have us believe,—namely, that concrete is *unsafe*, but because by some its appearance is less liked.

With those who entertain this opinion, the champions of concrete have no quarrel. In fact, they recognize that brick has its legitimate uses. Not so the proponents of brick, who seem to be able to see in concrete a pestiferous rival only, instead of a kindly disposed consort. And they cannot find things mean enough to say about it.

Let me pause at this point to remind our brick friends that cement, the essential ingredient of concrete,—that to which it owes its coherence, is precisely the material upon which brick masonry depends for its entity. So in condemning concrete as unsafe, they turn the lie on themselves.

That engineers and architects who are open-minded enough to perceive the merits, advantages and possibilities of concrete construction also recognize the value of brick, is attest-

¹Chicago

²*Brick and Clay Record*, Chicago

The writer in *Brick* speaks of the disadvantage of concrete beams intersecting concrete lintels, cutting off the light. True, they do; but what up-to-date engineer today designs a concrete building with intermediate floor beams carried to the lintels? If he uses floor beams at all, he confines them to the column lines and turns the lintel beams upward so that the windows extend quite up to the underside of the slab. The chances are, he will omit beams altogether except for the inverted lintels by designing in flat-slab construction,—a privilege afforded in concrete alone.

If our zealot for "safe factory construction" really is a devotee of truth, let him visit these three factories: Print Shop of Postum Cereal Co., Battle Creek, Burroughs Adding Machine Co., Detroit, and Willys-Overland Motor Car Co., Toledo. In all three instances he will find concrete used sensibly and brick in connection as it is really fitted. If, after seeing these fine examples of truly safe and sane factory construction, he is still of the same mind, I would advise him to see an alienist.

As for brick bearing walls—which is what I assume he means by a brick building—they are a snare and delusion. Ask your factory man in Omaha, where last spring they had such a disastrous wind storm, and in San Francisco, which a few years ago was swept by earthquake and fire,—ask them what they think of this kind of walls. Not only are they unsafe, but uneconomical; they encroach on valuable floor space, overload the foundation with dead weight, are a nuisance in construction if in conjunction with fireproof floors, and make impossible the adequate day-lighting of the interior. In regions subject to windstorm and earthquake, they are no longer permissible, and it is only a question of time when building ordinances country-wide will prohibit them, as sound considerations of economy and efficiency already do. If brick has a legitimate use in connection with the side walls of high-class factory structures, it is for curtain walls, filler and facing, no longer for bearing walls and piers. For these, monolithic, steel-stiffened and knit concrete, integral with the floor structure, is the only safe construction.

So much then for his contention as to the superior rigidity of brick construction. If in claiming for brick greater window area, he topples over backward, in this point he has somersaulted and landed on his face.

Equally ridiculous is his assertion that the greater elasticity of brick and steel (with wood floors) makes this construction preferable to concrete, when the very object sought

by managers is to secure a floor as solid and non-vibratory as possible, in pursuit of which they often purposely limit themselves to one story. There is no floor so satisfactory for manufacturing as a concrete floor on the ground, and with reinforced concrete alone is it possible to approximate equal solidity in floors above ground.

But our *Brick* proponent achieves the pinnacle of absurdity when he attempts to show that his hybrid construction of brick, steel and wood is cheaper than concrete. Now, not only are there numerous examples of

concrete costing no more than brick and mill construction, which is less costly than the type he cites (the beams being of wood instead of steel), but when the lower insurance and decreased maintenance and depreciation are taken into account, as in all fairness they must be, concrete in practically every instance is cheaper in first cost; and when compared with brick and steel *fire-proofed* (which means "despised" concrete floors and fireproofing on beams and columns), the all-concrete building invariably is the more economical and is not less efficient.

The Use of Hydrated Lime in Concrete Paving

A LETTER FROM HENRY S. SPACKMAN¹

[*Editors' Note*—The letter which follows was written by Mr. Spackman in answer to an inquiry as to his article published in the Dec., 1913, issue under the title: "The Cause and Prevention of Cracking in Concrete Roads." The inquiry in substance is as follows.]

The author mentions the marked improvement shown by the addition of 10% to 15% of hydrate of lime to the concrete mixture. Especial attention is called to the road built at Washington, D. C., and near Salisbury, Md., wherein this idea of adding hydrate of lime was carried out, but the kind of stone used in aggregate in the two above mentioned roads is not mentioned. We are building a few concrete pavements where the stone is a limestone running rather high in lime, and I am wondering if in our case there is not lime in sufficient quantities carried in the stone itself. May I inquire the nature and kind of stone used in the aggregates of the mixtures for the two roads mentioned?

The character of the stone would have no effect on the action of hydrated lime, and it would be as beneficial with limestone as with trap rock, gravel or other coarse aggregate. In limestone the lime is in the form of a carbonate and is inert.

I took no special note of the stone used near Salisbury, and cannot tell what it was. The stone used at Washington was a trap rock.

The hydrated lime referred to in my article is made by burning lime in the regular manner and hydrating it, only sufficient water being added

to meet the chemical requirements, and the resulting material is a finely divided dry powder. From this all coarse particles are removed by air separation or screening, and the final product is of very great fineness, and when mixed with water produces a plastic mass similar to the lime putty made by slaking lump lime.

The effect of the addition of this hydrate to concretes is greatly to increase their plasticity, and by making the mortar more viscous eliminates any tendency to segregation or separation of the sand and cement from the stone. As the resulting concretes are more dense and contain fewer voids, the water used in mixing has less tendency to separate from the concrete by seepage during the hardening period, and after hardening the concrete tends to have a more nearly uniform moisture content, owing to the fact that both absorption and evaporation are apparently retarded.

Using Rakes to Mix Sidewalk Materials

J. J. Anderson, contractor, Bridgeport, Conn., who has been laying sidewalks for the past 15 years, writes that he has always used a rake for mixing the bottom or foundation course, and has found that it makes a more perfect mix than if shovels only were used. Some contractors use heavy hoes with good success for mixing concrete. The suggestion to use a rake is of interest.

¹Henry S. Spackman Engrg. Co., Philadelphia

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa. Convention, Chicago, Feb. 16-20, 1914.

American Highway Association, J. E. Pennybacker, Jr., Secretary, Colorado Building, Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co., 72 West Adams St., Chicago, Ill.;

J. P. Beck, Sec. Seventh Chicago Cement Show, Coliseum, Feb. 12-21, 1914.

Interstate Cement Tile Manufacturers' Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago. Convention Feb. 17-19, Chicago.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. P. Beck, 72 W. Adams St., Sec. First meeting Auditorium, Chicago, Feb. 12-14, 1914.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

western States Portland Cement Co., Mason City, Ia. "Reinforced Concrete Fence Posts." Discussion on concrete fence posts, report of Committee on Form of Specifications. Business session: Report of Board of Direction, election of officers, revision of by-laws.

8:00 P. M.—"Modern Concrete Roofs Without Forms." J. E. Payne, Engineer, General Fireproofing Co., Youngstown, O. "Steel Forms in Concrete Construction." C. D. McArthur, Chief Engineer, Blaw Steel Construction Co., Pittsburgh, Pa. "Layout of Concrete Products Plants," E. S. Hanson, Chicago, Ill.

THURSDAY, FEB. 19

9:00 A. M.—Sectional meeting on Reinforced Concrete and Nomenclature, Frank C. Wight.

10:00 A. M.—Report of Committee on Reinforced Concrete and Building Laws, Alfred E. Lindau, chairman. Report of Committee on Nomenclature, F. C. Wight, chairman. "Full Sized Tests and Their Value in Concrete Construction," Burtis S. Brown, Consulting Engineer, Boston, Mass. "Test of a Reinforced Flat Slab Floor," W. A. Slater, engineering experiment station, University of Illinois, Urbana, Ill.

7:00 P. M.—Banquet.

FRIDAY, FEB. 20

9:00 A. M.—Sectional meeting on Concrete Materials and Surface Treatment.

10:00 A. M.—Report of Committee on Specifications and Methods of Tests for Concrete Materials, Sanford E. Thompson, chairman. "Some Comparative Corrosion Tests of Plastered Metal Lath—A Progress Report," J. C. Pearson, Bureau of Standards, Washington, D. C. "Data on Lime Putty and Cream of Lime," Cloyd M. Chapman, Engineer of Tests, Westinghouse, Church, Kerr & Co., N. Y. C. Report of Committee on Treatment of Concrete Surface, presenting revised specifications for stucco, Leonard C. Wason, chairman.

2:00 P. M.—Report of Committee on Sidewalks and Floors.

Tentative Program American Concrete Institute, Chicago, Feb. 16-20, 1914

The program announced tentatively for the convention of the American Concrete Institute, Chicago, Feb. 16-20, 1914, is as follows:

MONDAY, FEB. 16

10:30 A. M.—Meeting of the Board of Direction, Auditorium Hotel.

2:00 P. M.—Meeting of Sectional Committees on: Building Blocks and Cement Products, Education, Fireproofing, Form of Specification, Insurance, Nomenclature, Reinforced Concrete and Building Laws, Reinforced Concrete Highway Bridges and Culverts, Roads and Pavements, Sidewalks and Floors, Specifications and Methods of Tests for Concrete Materials, and Treatment of Concrete Surfaces.

8:00 P. M.—Formal Opening of the Convention, Auditorium Hotel; address of welcome to the City of Chicago; address of welcome on behalf of the architects; address of welcome on behalf of the engineering interests; address of welcome on behalf of the contracting interests; response by the President; business session.

TUESDAY, FEB. 17

9:00 A. M.—Sectional Meeting on

Concrete Roads and Pavements and Highway Bridges and Culverts.

10:00 A. M.—"Methods and Costs of Concrete Road Construction in Milwaukee County," H. J. Kuelling, County Highway Commissioner, Milwaukee, Wis.. Report of Committee on Concrete Roads and Pavements presenting revised specifications, C. W. Boynton, chairman. Report of Committee on Reinforced Concrete Highway Bridges and Culverts, Willis Whited, chairman.

8:00 P. M.—Annual address by the President, Richard L. Humphrey. "Progress and Development of Concrete Work on the Delaware, Lackawanna and Western Railroad," A. B. Cohen, Concrete Engineer, Hoboken, N. J. "Concrete, as Employed in the Construction of Wharves, Quay Walls and Dry Docks, at the Brooklyn Navy Yard," F. R. Harris, Civil Engineer, U. S. Navy, Brooklyn, N. Y.

WEDNESDAY, FEB. 18

9:00 A. M.—Sectional Meeting on Concrete Products, Blocks, Tile, Pipe, Fence Posts, etc.

10:00 A. M.—Report of Committee on Building Blocks and Concrete Products, presenting specifications for fence posts, blocks, etc. "Standard Specifications for Drain Tile," A. Marston, director, Iowa Engineering Experiment Station, Ames, Ia. "Result of Tests on Plain and Reinforced Concrete Tile," George P. Diekmann, chief chemist, North-

Convention of Iowa Association of Cement Users

The convention of the Iowa Assn. of Cement Users was held at Ames, Ia., Jan. 8-10, with about 300 engineers and cement users in attendance. C. M. Powell, of the Universal Portland Cement Co., made a survey of the "Future of Cement." Prof. R. C. Crum made an address on "Prac-

February, 1914

tical Methods of Cement Testing." P. P. Comoli, Sioux City, Ia., spoke on the subject, "Architecture for Concrete Buildings." J. P. Marsh, of the Marsh Engineering Co., summarized the developments in concrete bridge building. A. B. Becker, of the Universal Portland Cement Co., described concrete road building in Wayne County, Mich., the talk being illustrated by moving pictures. Geo. P. Diekmann, Mason City, Ia., spoke on the subject of "Aggregates," and H. F. Anthony, division engineer of the Mississippi Power Co., described construction work of the Keokuk dam. A joint meeting was held with Iowa highway engineers, who were also in session at Ames. F. P. Wilson was succeeded as president of the organization by J. B. Marsh, Des Moines; other officials elected are A. S. Tanner, Jefferson, vice-president; P. P. Comoli, Sioux City, vice-president; Geo. P. Diekmann, Mason City, secretary and treasurer. It is probable that the next convention of the organization will be held in Mason City.

The Wet Concrete Patent Settled

Alexander D. Ney, who has held the letters patent from the U. S. Patent Office governing the pouring of wet concrete, recently sued the City of Aurora, Ill., for infringement. The case was tried in the U. S. District Court of the Northern District of Illinois. It was established, of course, that pouring concrete wet was in common and almost universal use many years before the application for the patent, and this fact was established in several specific instances. The court found that these letters patent, No. 939,072, were anticipated and void and that the defendant, the City of Aurora, did not in any way infringe any possible construction of the patent. The court found that the bill was without equity and ordered it dismissed at the complainant's cost.

When the suit was first brought, early last fall, J. Bruce Amell, city atty., requested CONCRETE-CEMENT AGE to gather specific instances in which wet concrete had been used. We started out many letters to representative concrete engineers who wrote either to us or Mr. Amell, giving their past experience of wet concrete. We acknowledge here the cordial co-operation of these firms which materially helped in settling such an absurd contention as the Ney "Wet Concrete" patent.

New Books

Concrete Specifications—By Jerome Cochran, B. S., C. E., M. C. E., published by D. Van Nostrand Co., N. Y. C., 9 1/4" x 6 1/4" cloth, 271 pp., illust., price \$2.50.

This volume is a comprehensive compilation of specifications covering the handling of concrete and reinforced concrete. The book is to be commended especially because of the very effective arrangement of the text matter. Not only are the different subjects grouped in very definite chapters, but each chapter is divided into articles covering specific divisions and each paragraph is numbered serially, starting at the beginning and continuing with the same series right through to the end. This gives each paragraph a definite number.

In the text will be found many suggestions, some very useful and some not quite so applicable to everyday work. The paragraph discussions are, as a whole, clearly, definitely and briefly stated. At the end of each chapter the author lists a complete bibliography of specifications covering the subject treated in the preceding chapters.

The chapter headings are: Concrete Materials; Proportioning and Mixing Concrete; Forms and Centering; Steel Reinforcement; Transporting and Placing of Concrete; Finishing Concrete Surfaces; Waterproofing Concrete Works; Design of Reinforced Concrete; Reinforced Concrete Building Construction; Appendix A, Suggested Formulas for Reinforced Concrete Construction; Index.

The author states in the preface that his sole purpose has been to produce a set of specifications which will be of increasing influence toward good concrete construction.

Journal of The Am. Soc. of Mechanical Engineers—Published by the Society, N. Y. C., 12" x 9", paper, 60 pp., illust.

This is the first issue of the *Journal* in its new size and the Society is to be congratulated upon a publishing achievement. The *Journal* is now standard size, 9" x 12", with a 6" x 9" page, and a two-column make-up. It is a *Journal* worthy of a leading American engineering society.

Journal of American Concrete Institute—Published at the Office of The Institute, Harrison Bldg., Philadelphia, 9" x 6", paper, 48 pp., illust.

This is No. 1, Vol. 1, the first issue of the *Journal* of the American Concrete Institute. In Part I of the *Journal* the reasons for the change of name from the National Association of Cement Users to the American Concrete Institute are given, the personnel of the various committees is presented, and there is also presented a synopsis of recent articles on concrete. Part II presents Committee Reports and the paper on the "Effects of Electric Current on Concrete," which was presented at the Dec., 1912, convention of the Institute.

Test of a Reinforced Concrete Highway Bridge—By D. A. Abrams, published by Am. Soc. for Test. Mat., Philadelphia, 9" x 6", paper, 38 pp., illust.

This booklet describes in detail the test of a 40-ft. reinforced concrete highway bridge. This bridge was built in 1907 and tested in 1908. The paper is an authorized reprint from the 1913 Proceedings of the Am. Soc. for Test. Mat.

Modern Automobile Design, Construction, Driving and Repair—Norman W. Henley Pub. Co., N. Y. C., 7 1/2" x 5 1/2", cloth, 622 pp., illust.

Automobiles and motor trucks are used very widely in the building field; busy engineer contractors use automobiles to get around from one job to another, and motor trucks of all kinds are used in handling materials. This book is a detailed text, consisting of questions and answers and many illustrations, covering in detail the mechanism of the modern automobile. It should be found of value to all contractors having these problems to handle.

West Virginia Geological Survey. By C. E. Krebs, Asst. Geologist, and D. D. Teets, Jr., Field Asst., Morgantown, W. Va., 9 1/4" x 6 1/2", cloth, 484 pp., illust.

This booklet is a detailed report on Cabell, Wayne and Lincoln Counties, W. Va. It is accompanied by a complete set of maps and furnishes a very comprehensive report on the work done.

Snow Sheds in the Cascade Mountains

In the Jan., 1914, issue there was published an article describing concrete snow shed construction in the Cascade mountains. For the notes and photographs of this work we are indebted to H. C. Raymer, of the Contractors Equipment Co., Seattle, Wn. Through an oversight, credit was not given in the article in question.



FIG. 1—A MODEL OF THE AUSTIN-NICHOLS WAREHOUSE TO BE BUILT IN BROOKLYN, N. Y.

This building is 460' x 180', 6 stories high, and designed for a live load of 300 lbs. per sq. ft. It is the largest wholesale grocery warehouse in the U. S.; Cass Gilbert, architect; Turner Const. Co., builder

Mandatory Fireproof Construction and the Economy of Concrete

By J. P. H. PERRY¹

For New York state and the East in general, 1913 was a banner year in that it brought forth the enactment of the State Labor Law requiring fireproof construction for factories of over four stories; and, too, it demonstrated the structural economy of reinforced concrete over all other forms of fireproof construction, in the award of the Austin-Nichols warehouse contract.

The following notes, which appeared in a recent issue of the N. Y. Evening Post, detail in a most interesting manner the relation of these two important happenings which mean so much for concrete development:

There have been two very important developments recently affecting reinforced concrete construction. While wholly distinct one from the other, they bear in some ways a close relation. The first was the enactment of the new State Labor law, effective Oct. 1, 1913, and second, the award of the contract for the construction of the new warehouse for Austin-Nichols Co., Inc., at North Third St. and Kent Ave., Brooklyn.

The State Labor law, now being enforced by the Industrial Board, provides that all factory buildings over four stories in height shall be of fireproof construction. When it is remembered that there are 34,000 factories in N. Y. C. alone, exclusive

of the New Jersey portion of the metropolitan territory, and the whole of the State of New York and western Connecticut, which all more or less feel the influence of the great metropolis, it can be readily appreciated how important a step in the development of concrete construction this drastic law is.

OPTIONAL FACTORY CONSTRUCTION

The industrial builder up to the present time has had the choice of three methods of construction—really four methods. The cheapest, an all-frame proposition; a little further up in the scale of efficiency, mill construction (brick walls and heavy yellow pine floors and columns), and two forms of fireproof construction, reinforced concrete or fire-proofed structural steel (with cinder concrete, stone concrete, or terra cotta). As a matter of fact, in N. Y. C. the industrial buildings in the past 10 yrs. have been built mostly of either mill construction or one of the two fireproof forms just noted—the major part being of the cheap slow-burning type. These buildings have been permitted to a height of six stories.

OPERATION OF THE NEW LAW

The effect of the new law is to wipe out from future consideration five-story and six-story mill buildings. Owing to the land values in the greater city, most of the new industrial buildings have to be over four stories tall, and it is readily seen that from now on the factory or warehouse man in putting up new buildings will have to choose between concrete and steel frame fireproofed.

The letting of the Austin-Nichols Co. warehouse contracts, described in the following notes, throws clear light on where the choice between these two types of construction will probably lie.

CONCRETE IN THE METROPOLITAN TERRITORY

The first concrete building in the metropolitan territory was built in 1898. In the 15 years which have elapsed, there have been constructed probably 400 concrete factories, warehouses, and other industrial buildings. Practically speaking, however, the use of reinforced concrete for building construction in this territory dates to the construction of the first Gair Co. building in Brooklyn in 1904-1905, or a little over eight years ago.

During this time the various concrete construction companies, backed up by the publicity campaigns of the cement manufacturers,² have fought a long, hard battle to convince investors of capital, industrial executives, architects, and engineers that their material produced an absolutely satisfactory building worthy of the confidence of money and secure against every service test and permanent to the last degree. Slowly but surely their fight has been won and it is pretty generally accepted today that a well-constructed reinforced concrete building is the equal of any building within its limits of usage, which are, generally speaking, along industrial lines.

ECONOMY OF CONCRETE

While those directly interested in the reinforced concrete game have realized for a long time that they could construct factories and warehouses cheaper than any other form of fireproof construction, it has been hard work to make the great body politic come to this point of view. The bringing about of a popular ac-

¹Turner Const. Co., N. Y. C.



Fig. 2—The Loose-Wiles Biscuit Co. Factory, at L. I. City, Nearing Completion

This building is 440' x 200', 10 stories high. The floor loads vary from 150 lbs. to 3,000 lbs. per sq. ft. It was built at the rate of 10,000 sq. ft. of floor per working day, a speed record in concrete construction. William Higginson, architect; Turner Const. Co., builders. The view was taken Nov. 18, 1913

ceptance of this fact had to be through the architectural and building professions. The percentage of architects who deal in reinforced concrete construction has been very small. The big well known firms of the city as a rule have not handled industrial work, confining their efforts largely to the hotel, office, loft, apartment, and residential buildings. The big construction companies, which the general public have gotten to know by their signs on the monumental buildings which have gone up in this city for the past 10 years, have rarely had to tackle the factory and warehouse, and when they did figure the jobs they were not considered of great importance.

A SIGNIFICANT COMPETITION

Last September, however, Cass Gilbert, designer of the Woolworth Bldg., the Custom House, and the West Street building, sent out plans to some 25 bidders for a million-dollar terminal warehouse for Austin, Nichols & Co., reputed to be the largest wholesale grocery concern in the world. The list of bidders included most of the biggest building contractors in the eastern territory. The plans were drawn for the standard structural steel fireproofed type of building, and as well for an alternate in all reinforced concrete design. After the bids were received, it was found that the building cost considerably more money than was available, and most of the bidders were asked to re-figure, offering their

experience, and any economizing alternates that suggested themselves.

Right here is the crux of the whole matter, and the great lesson which the building interests of N. Y. C. should read, mark, learn, and inwardly digest. Twenty odd of the cleverest structural steel contractors turned their estimating and designing forces loose to try to work out the most economical design for a building, 167' x 180', six stories high, 300 lbs. floor loads, where the cu. ft. or the sq. ft. price was the determining factor—in other words, where economy was a *sine qua non*. There were some four concrete companies in the competition. After over two months' figuring and re-figuring, and the smoke of the battle had cleared, it was found that the concrete bidders had beaten the best efforts of the structural steel people by over 8%, and the contract was awarded for an all-reinforced concrete building.

Never before has there been such an opportunity to determine in an impartial, absolute manner the relative costs of concrete and steel. To be sure, on the Frederick Loeser & Co. warehouse, constructed in Brooklyn in 1908-1909, bids were taken from a small list of contractors on plans drawn in both steel and concrete, and in this case concrete won by 12½%. There have been also a number of other small competitions between steel and concrete which almost always have shown a saving in favor of concrete of from 10% to

20%, but these jobs have not been of sufficient importance to bring before the big elements of the architect and building life of this great city the incontrovertible fact that for an industrial building concrete construction is the cheapest fireproofed form now on the building market.

Take these two developments together—the new labor law and the Austin-Nichols competition, and you have written on the wall of the future in incandescent flashing letters a great increase in the use of concrete construction in this city.

THE FUTURE IN THE LIGHT OF THE PAST

The acceptance of reinforced concrete for general industrial buildings could not be so certainly prophesied were there not numberless examples of the satisfactory use of concrete for factories and warehouses. If the concrete buildings which can be referred to were small, isolated manufacturing, the position of concrete in the next few years would not necessarily be as secure as it seems to be, but one has only to cite such examples as the 14 loft buildings of the Bush Terminal Co., giving 125 acres of floor space; the lofts of the New York Dock Co.; the seven Gair Co. buildings; the 10-story manufacturing loft of the Hoboken Land & Improvement Co.; the 10-story terminal warehouse of the Baltimore & Ohio R. R. Co.; the 10-story Loose-Wiles Biscuit Co. factory, with floor areas of 1,000,000 sq. ft.; the Brewster

building; the Thompson-Norris Paper Co. building, etc., etc., to prove to any financial syndicate or other form of capital investment the absolute satisfaction which this form of construction gives.

CONCRETE IN TERMINAL DEVELOPMENT

There is another phase of the industrial building development in this city which should have careful study, and that is what might be called the terminal situation. There are at the present time a number of active or about to be active freight terminal schemes where concrete rules supreme. Among these might be cited Bush, Brooklyn Eastern District, New York Dock, Hoboken Land & Improvement Co., Degnon Realty & Terminal Co., Palmer, New York Freight, Bronx, and New York Central. Wherever actual building construction has proceeded to date, reinforced concrete has been used to the exclusion of other forms of construction.

One has only to sit back and dream for a few minutes of the future of the railroad, market, industrial, and freight terminal developments of this great city to see that the great mass of cramped industries which are now housed on Manhattan are going to move to Brooklyn, Queens, and New Jersey, to modern buildings, fireproof in every detail, where maximum light, sanitary quarters and greater room can be secured at the lowest possible dollar value.

CONCRETE MOST ECONOMICAL AND EFFICIENT

Glance for a moment at Queens: The Loose-Wiles Biscuit Co. factory, a \$2,500,000 building, was built this year of reinforced concrete, with a terra cotta veneer, after a long study by the financial syndicate back of it of various types of building construction, and the contract for the great building was awarded in the firm belief that concrete construction, from all points of view, was the most economical and efficient to be found. The investment of money, which was a large one for an industrial building, was made without any doubt as to its security. Adjacent to this big biscuit factory are half a dozen buildings, such as automobile service factories, a card factory, garages and automobile body plant. To say nothing of the proposed buildings for factories and warehouses, which will run to \$8,000,000 or \$10,000,000 in the next few years. Practically all of these buildings are, or are going to be, of reinforced concrete construction.

CONCRETE POPULAR

So far we have discussed only the big developments where the million-dollar building is the rule. If we turn now to the more frequent use of concrete in factories and warehouses costing from \$50,000 to \$250,000, we find an equally interesting situation. The largest firm of concrete contractors in the city in the year 1913 more than doubled its business over its previous year—handling some 25 contracts for buildings. Most of these were four-story to eight-story buildings having from 50,000 sq. ft. to 100,000 sq. ft. of floor space each—buildings erected by generally unknown manufacturers for their own use. Propositions of this kind mean that the man putting up the money has spent weeks or months studying the building material market and investigating for himself the relative merits of the different types of construction and satisfying himself beyond a reasonable doubt that concrete for his own building would be a safe investment of his money.

CONCRETE A STANDARD BUILDING MATERIAL

In an experience of a number of years as contract manager of a large firm of concrete builders in the eastern territory, I have found that the general business development of reinforced concrete construction has changed a great deal. Whereas, up to perhaps three years ago most of the time of the business getter of the concrete contractor was spent on missionary work for concrete—that is, he would hear of a proposed industrial building and usually have a lot of hard work to convince a prospective builder that he should use concrete construction instead of mill construction or brick; today 95% of the business done comes to him as concrete from its first inception. The missionary work is wholly on behalf of the company seeking the business. Concrete construction is generally accepted as the most economical and efficient form of building for industrial purposes, and very little advertising or soliciting has to be done to convert a progressive executive to the use of concrete.

COST OF MATERIALS IN 1913

There was a great volume of reinforced concrete work in 1913. Not only were the most experienced concrete contractors kept busy handling all they could possibly execute, but a number of new concerns entered the field and usually found enough business to keep them going. This is somewhat remarkable in view of the fact that cement and steel have

both been higher than in several years. Cement touched 95 cts. a bbl. net at the mill, and steel reached \$1.45 f. o. b. Pittsburgh for bars. Gravel and sand maintained about the same prices for the past two years.

Labor has not increased its wages to amount to anything, though perhaps its efficiency, due to more experience and greater familiarity with concrete construction, has improved. The cost of concrete buildings has not changed materially the last two or three years. Compared, however, with the early costs, it has slowly decreased. In fact, it is probably the only standard product which has not followed the upward curve so often termed "high cost of living." Concrete buildings today cost about 8% to 10% less than they did in 1903, 1906, 1907.

THE 1914 OUTLOOK

In thinking over the 1913 developments in the use of concrete, and what the future apparently holds out, one cannot help but be enthusiastic over the concrete prospects. What with the new labor laws and the absolute economy of concrete compared with steel, and the great terminal developments already referred to, together with the general movement of industries out of Manhattan into modern buildings, there should be a tremendous increase in concrete work in this territory in 1914.

Canada Cement Co. Closes Four Plants

The Canada Cement Co., Ltd., announces that owing to dullness of business it has decided to close down, for the balance of the year 1914, or until further developments, plants No. 6, Marlbank, Ont., No. 7, Lakefield, Ont., No. 9, Shallow Lake, Ont., and No. 10, Calgary, Alta. It will not, therefore, be prepared to receive shipments of empty bags returned to any of these mills after Feb. 1. Return of empty sacks made to any of the other mills will have prompt attention.

Doors on a Maryland Silo

On p. 232 of the Nov., 1913, issue, we described a concrete silo built by D. D. Frederick, Dove, Mo. The article referred to the doors as being 2' x 6'. Mr. Frederick writes that the doors are 26" x 30". We are glad to make the correction.

Concrete in Drainage and Irrigation—Clean Materials and Dense Mixtures¹

By J. H. LIBBERTON²

The paper from which this matter is taken was read to users of concrete tile—to agricultural engineers, and is of interest to manufacturers as indicating the standards which users expect in their products, and is useful also as ammunition for the sales end of the tile business in approaching prospective users on the subject of the advantages in concrete tile.

It is but natural that concrete should obtain considerable recognition in the installation of drainage and irrigation projects, just as it has in the numberless other fields into which it has entered. The materials of which it is composed may generally be located within a reasonable distance from the project and local labor may be used in the construction. Emphasis must be laid continually on the necessity for obtaining good material, since poor, dirty or otherwise unsuitable aggregates are responsible for many failures of concrete. The aggregates must be clean, hard and well graded, with the coarser particles predominating. Clean, because if the separate particles are covered with a coating or film of any kind the cement cannot form a good bond with the surface. As a chain is no stronger than its weakest link, so concrete is no stronger than the weakest particle of which it is composed. Consequently, the aggregate must be hard, and remain hard under all weather conditions.

Some sands and gravels contain shale-like particles which after exposure to weather for a short time go to pieces. When such particles occur in the tile wall, oftentimes the absorption of moisture causes them to swell and split, breaking large pieces of concrete out with them; nor will stone of a chalky nature give good results. Coarse particles should predominate, because a coarse aggregate presents a smaller surface area for the same volume and is also more easily covered with cement than a fine one, thus making stronger concrete with the same proportion of cement.

The sand must be free from an excessive amount of fine material, although small amounts are conducive to imperviousness, which is always to be desired when concrete is being mixed for use either in drainage or irrigation work.

With good materials and good workmanship it is possible to produce concrete of such quality as will indefinitely defy the elements. Porous concrete will defy nothing and whether placed above or below ground is a prey to every destructive action.

It has sometimes been contended that concrete is unsuited for underground drainage because of its inability to resist the action of ground water. In reality, concrete hardens best under water and if it is of first-class quality the conditions are ideal for the development of maximum strength.

POROSITY UNDESIRABLE

The early manufacturers of concrete tile were not cognizant of the requirements of strength and imperviousness but rather believed that the best drain tile was the one most porous. In reality the joints are sufficient to take in all the water which comes to the drain line. Then, too, no matter how porous the fresh concrete tile may be, a short time after its introduction into the drain the pores begin to fill with silt and their draining value is removed. The introduction of silt, however, adds nothing to the strength of the tile, and the continual flow of water through the line has sometimes been sufficient to wear away the lower part of the tile completely, leaving nothing standing but the crown.

The reason for the extreme porosity achieved may be traced first to lack of cement and second to extremely dry mixtures. The reason for the little cement used in the early manufacture of drain tile may probably be traced to the original manufacturers of tile machines, who were more anxious to dispose of their wares than to insure the good reputation of the cement tile industry. With this in view, their recommendation was more often 1 part of cement to 7 parts or 8 parts of sand, than 1 part of cement to 3 parts of sand, which is now recognized as none too

rich. The reason for recommending a dry mixture may be that a porous tile presented a selling point which the tile manufacturer could demonstrate to the easily convinced buyer.

A customary demonstration which never failed to prove the value of concrete tile for drainage was to pour a glass of water over the outside surface and see it appear almost immediately in moisture on the interior. This, happily, has been done away with almost entirely, and manufacturers now appreciate the need for every precaution which will insure a dense and impervious concrete.

There are several shorthand methods of quickly determining the quality of concrete drain tile. The first is by tapping the tile with a hammer, or piece of metal, and noting the quality of the ring. The emission of a sharp metallic ring indicates the superior quality in the product, while a wooden-like sound furnishes sufficient cause for rejection.

WET MIX DESIRABLE

Practically all of the smaller sized tile are made in an outer jacket by means of an interior rotating packer head, which packs the concrete between itself and the jacket. When a sufficient amount of water is used, the quick removal of the outer jacket is sometimes difficult and as a result, manufacturers are tempted to decrease the amount of water to the lowest possible point, in order to increase the output. A very easy check on whether or not sufficient water has been used is found in the web-like markings which always appear on the outside of tile in which sufficient water has been used. These are caused by a slight adhesion between the jacket and the tile upon the removal of the former.

Another indication of the quality of concrete tile is presented in the absorption test, which is made by immersing the specimen in water for 48 hrs., after having been dried to constant weight and weighed. The increase in weight should not be over 4%.

Final acceptance of the tile should be made upon the strength which they develop. There is no need for trying to approximate ditch conditions in the methods of testing employed, but rather to ascertain whether or not the tile is of sufficient strength to withstand the load which will be applied to it in the ditch. In reality every ditch in which tile are placed presents a new type of loading, depending upon the care in the preparation of the bed. Many times the tile rest only upon a line along the bottom.

A commercial machine is now mar-

¹Portion of paper read before recent meeting of Am. Soc. of Agricultural Engrs.

²Universal Portland Cement Co., Chicago

keted which provides for what may be known as the three-point loading along two lines parallel to the axis at the bottom of the tile, and along a similar line parallel to the axis along the top. By this method accurate and uniform results have been obtained which have justified its adoption by a number of drain tile manufacturers as standard. It is possible also for the purchaser of tile to adopt this machine and with the specifications which are now under consideration by the Am. Soc. for Test. Mat., it will be possible to accept or reject tile upon actual strengths obtained.

EFFECT OF ALKALI

Because of a lack of sufficient strength, tile have sometimes collapsed in the ditch, and those opposed to concrete for drainage purposes have seized upon such failures as reason for advising against the use of concrete tile of any quality. Such failures have often been credited to the action of ground water "alkalies." In reality the true cause has been poor tile. P. H. Bates, chief chemist of the Bureau of Standards, who has made a considerable investigation of "alkali" in the United States, and its effect upon concrete, states that the more widely distributed white "alkali" consists of sulphate of soda or a mixture of this with sulphate of magnesia. Other "alkali" action has been reported and salts are present in comparatively slight quantities only. The black "alkali" is largely carbonate of soda. Of this "alkali" the one which most actively attacks concrete is the mixture of the sulphate of soda and magnesia, the others being comparatively harmless.

Richard L. Humphrey, pres. of the Concrete Institute, recently stated before the Internat. Assn. for Test. Mat. that many defects of workmanship and materials are attributed to "alkali" action. Mr. Humphrey and the writer have both visited the principal works in the far West where there is only one district confined to a small portion of Wyoming and South Dakota in which the black "alkali" seemed to have attacked the concrete to any appreciable amount and even at this location there remained a good deal of question as to the quality of the concrete in doubt. The destruction was due, primarily, to the rapid evaporation from the extreme dryness of the atmosphere, causing immediate crystallization of this "alkali" salt in the concrete. The more dense the concrete, the less destructive is this action. In all probability after the concrete has been broken down, chemical action also takes place. The

rapid formation of crystals causes a swelling or increase in volume, which has the same destructive action as frost.

It is generally overlooked, however, that this action is not confined alone to concrete but similarly affects brick, stone and other building materials. The modern application of concrete being comparatively recent, any failure of this material naturally attracts more attention than the failure of material that has been used for a greater length of time.

Technologic Papers, No. 12, of the Bureau of Standards on the "Action of the Salts in Alkali Water and Sea Water on Cements," which has been published recently, sums up the operations of the department in this regard, as follows:

1. Portland cement mortar or concrete, if porous, can be disintegrated by the mechanical forces exerted by the crystallization of almost any salt in its pores, if a sufficient amount of it is permitted to accumulate and a rapid formation of crystals is brought about by drying; and as larger crystals are formed by slow crystallization, there would be obtained the same results on a larger scale, but in greater time if slow drying were had. Porous stone, brick, and other structural materials are disintegrated in the same manner. Therefore, in alkali regions where a concentration of salts is possible, a dense, non-porous surface is essential.

2. While in the laboratory an hydraulic cement is readily decomposed if intimately exposed to the chemical action of various sulphate and chloride solutions, field inspection indicates that in service these reactions are much retarded if not entirely suspended in most cases, due probably to the carbonization of the lime of the cement near the surface or the formation of an impervious skin or protective coating by saline deposits.

3. Properly made Portland cement concrete, when totally immersed, is apparently not subject to decomposition by the chemical action of sea water.

These conclusions were arrived at after a period of $3\frac{1}{2}$ years of continuous experimentation, and although not absolutely conclusive are fairly indicative of the confidence of the Department of Commerce in the ability of good concrete to withstand the action of any "alkalies" generally met with in drainage or irrigation operations.

Another point which is not generally given consideration in the solution of our drainage problems is the concentration of "alkali," due to surface irrigation, without provision for underdrainage. The continual flooding of "alkali" water over a district causes a concentration of the salts on the surface from evaporation and unless this is carried away by some means of underdrainage the soil is

not only in poor condition for cultivation but also has an abnormal effect upon any building material which is used in its vicinity. With adequate underdrainage there is no chance for a concentration of salts since a continual flow from the surface to the drain keeps the soil in normal condition.

Were any considerable amount of difficulty encountered, the concrete tile industry would not have increased with such exceptional rapidity. In 1905 the first plant was established and in 1911 a total number of 372 plants were in operation, with a yearly output of over 150,000,000 ft. Lean mixtures and lack of proper workmanship militated against the more rapid development, but with the appreciation which seems to be felt today of the need for plenty of cement and every care in manufacture, there is no reason why enormous strides should not be made in the future toward developing this industry.

Sidewalks and Pavements of Concrete, Grenoble, France

In converting metric measurements to equivalents in feet in the article, p. 23 in the Jan., 1914, issue, under the title, "Notes on Sidewalks and Pavements of Concrete in Grenoble, France," we unfortunately made a mistake and repeated the mistake three times. In paragraphs 3, 4 and 6 of the road specifications the equivalent of .05 m. should be .164 not .016, as stated. This was an editorial error, not an error of the authorities supplying the information.

From an introduction in the latest catalog of the Anchor Concrete Stone Co.,¹ we quote:

We advise the use of the plain block, made wet, for all kinds of buildings. Do not try to imitate rock-faced stone or other plates making the various imitations, but build a real concrete block equal to cut stone in appearance and strength.

Moreover, an advantage that cannot be overlooked is that a plain block can be made from much wetter concrete than a block with an imitation or fancy face. If a builder wants to break up the flat appearance of his wall, it can be done with panels, pilasters and belt courses, giving the completed building a clean, stately and sturdy appearance, that cannot be secured by using imitation face blocks. The popular and useful block, in the future, will be the plain block made from a wet mixture, well and uniformly tamped. Concrete, as a building material, has "come into its own" and its users need no longer make an effort to try to make it look like something else by attempts to imitate a rock or any other building material.

¹See Aug., 1913, issue, p. 69, "Concrete In Alkali Soils"

²Rock Rapids, Ia.

Using Steam to Heat and Cure Double Walls in Cold Weather

The great cost of insuring and keeping up a large number of widely scattered buildings is a matter that is receiving much attention from railroads and corporations at the present time. The fact that these scattered plants must be erected largely by local labor and materials has worked against modern construction. To a milk company, whose stations are scattered over several states, the question of sanitation and insulation is also of especial interest. H. P. Hood and Sons Co., Boston, has given this matter considerable attention as it is building constantly.

Late in the summer of 1913, this company lost by fire a small plant located near Wells River Junct., Vt., and it was decided to replace this

plant with concrete. Hollow wall construction was decided on as being particularly adapted for use and Van Guilder machines were adopted because they are light, can be easily and cheaply transported between widely scattered plants, and being simple to operate, the necessary help can be secured locally.

THE CONSTRUCTION USED

The wall construction adopted to rebuild the milk station at Wells River Junct. was two 4-in. walls separated by an air-space of 2½" for insulation purposes. This double construction is particularly desirable

¹Van Guilder Hollow Wall Co., Rochester, N. Y.

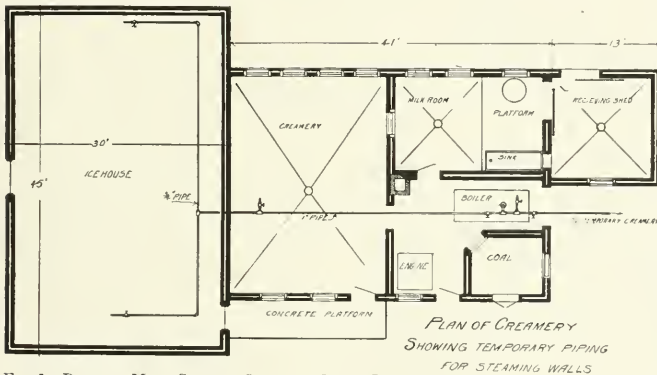


FIG. 1—PLAN OF MILK STATION SHOWING STEAM LINES USED

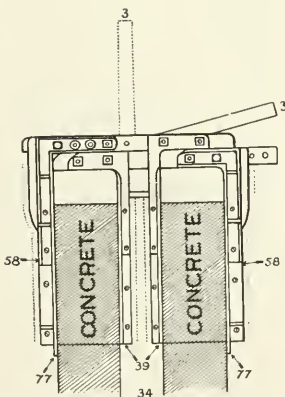


FIG. 2—DETAIL SECTION SHOWING THE OPERATING FEATURES OF THE VAN GUILDER DOUBLE WALL MACHINE

wherever a high degree of insulation from heat and cold is desired, and it also effectually prevents dampness.



FIG. 3—GENERAL VIEW OF MILK STATION CONSTRUCTION

The rebuilding was delayed for various reasons until after Nov. 1, and as the plant was located almost at the base of the White Mountains, the builders were considerably perplexed to know how to keep the walls from freezing, and as to whether or not they would set fast enough to allow continuous work with the wall machines.

As the buildings consisted of an ice-house 30' x 45' with walls 19' high, a creamery 41' x 30', and a receiving shed 13' x 15' with walls 12' high, there was a large exposed area to be protected from the cold. There was a boiler on the premises that had been in the burned creamery and this suggested to C. D. Gilbert, representing the Van Guilder Co., that steam might be turned into the continuous air space and the walls steam-cured. Plenty of old pipe was at hand and lines were run so as to reach every part of the building by means of steam hose connected to the walls. As fast as built, the walls were covered with strips of tar paper, weighted with boards, and steam turned on, with the result that the concrete set in about 3 hrs. so as to allow another course to be laid, and was past danger of freezing in 6 hrs. All of the walls were erected in three weeks. The thermometer went as low as 20° F., and there was at one time 1" of snow, yet the work was carried on successfully.

This is evidently a solution of the problem of how to protect and cure double concrete walls in cold weather, and will no doubt result in extending the season for this type of construction work several months, as the results are positive and the cost very small. In fact, this steam curing process should put concrete in its proper place among building materials where double walls are specified, as it can be used in any weather suitable for other construction work.



Fig. 4—WORK UNDER WAY AT THE HOOD CREAMERY CO.'S NEW BUILDING

In the wall angle at the left is shown the hand hoist arrangement for elevating the concrete

Making Concrete Posts Economically

In the making of concrete fence posts, one of the main features is to see to the economical arrangement of the equipment, with reference to the items of labor and handling the aggregates and finished products.

By making use of the incline of an idle coal chute upon its line, the S. P., L. A. & S. L. Ry. Co. has devised in western Utah a plant for the economical manufacture of concrete fence posts upon its lines. The gravel is received in dump cars, run up the incline and dumped into bins built in the trestle work. An inclined trough is connected to a small opening in the bottoms of the bins leading out to the mixer, through which the gravel travels by gravity. While it is in the trough accurate measuring is accomplished by the opening and closing of gates placed at desired intervals for various quantities. Upon raising the gate in the end of the trough which is directly over the feed chute of the mixer, it runs into the mixer without further attention. The mixer, which is of the batch type, is mounted upon a raised platform and at the time of dumping the gravel into the mixer the desired amount of cement and later on water is supplied and the aggregate mixed to the consistency of mortar for wall plastering, which has been found to give the best results. D. & A.¹ equipment is being used at this plant, including 10-mold machine, together with a large number of extra molds,

also anchor and brace molds, sufficient to keep several men working steadily. The mold bed has been mounted upon trucks and with molds in position for filling is run under the discharge of the mixer, and sufficient concrete to fill the 10 molds level full is dropped into them, at one time. The concrete is then leveled in the molds, reinforcement placed, and the concrete compacted in the usual manner, when the filled molds are ready to be removed from the frame, other molds replacing them, and the filling operation is repeated.

Twenty-four hours after putting the concrete in the molds, it has taken the initial set and the posts are removed from the molds and stood directly upon end or laid out upon soft, level ground. They are left for about 60 days before using in order to let them cure.

With no handling of the materials by hand, and by the use of gravity, it is possible to make concrete fence posts at a cost to compare favorably with that of wood posts.

An official of the railroad writes: "We built 23 miles of fence last year, using concrete posts 16' 6" apart, and five barbed wires and the cinch wire fence stay, using one between every two panels. It is a very pretty fence and is attracting considerable attention in this part of the country. I had better success in making the posts the latter part of the season owing to my men getting more familiar with the work."

The plant is at Lynndyl and in charge of F. M. Bigelow, Supt. B. & B.

Ten Rules to Eliminate Building Failures

Failures happen at times in all lines of construction work, but it is to be regretted that whenever concrete is involved in any way, the disaster becomes "another concrete failure." Steel, brick and timber construction fails, too, but, as for instance, in the Quebec bridge failure, it was not a "steel failure," but a "bridge failure," a failure in design or workmanship. Concrete, however, is in the spot light, and must carry the brunt of blame, as well as receive praise and admiration.

Failures can be, and should be, avoided, by proper, intelligent precautions and workman-like methods. The following 10 rules, by W. P. Anderson,¹ are a valuable guide to better practice:

1. All buildings should be designed by a competent engineer and erected by contractors with special experience in this line of work.
2. In winter weather the sand and stone aggregate entering into concrete should be heated before concreting. One good method of doing this is to blow steam into the pile of material.
3. The water used in mixing should be warm but not hot. The temperature of the water should not be over 130°. Water above this temperature is harmful to the cement.
4. Avoid concreting when the tem-

¹D. & A. Post Mold Co., Three Rivers, Mich.

¹Pres. Ferro-Concrete Constr. Co., Cincinnati

perature is below 25° or when there is any likelihood of a sudden drop in temperature. Consult the U. S. weather reports for this information.

5. After concreting in cold weather cover the floors with straw.
6. Keep salamanders going under the concrete work and enclose all openings around building so that the heat can be confined.
7. Watch the shoring carefully during concreting, as occasionally an imperfect shore due to a knot or some other cause may be used which should be replaced immediately.
8. Leave all shoring until concrete has thoroughly set. Form work may be removed much sooner than the shores and when this is done, care should be taken to wreck only a small section at one time before re-shoring. Where the weather is apt to be below freezing for several weeks at a time in the winter it is better to leave the beam bottoms under the beams so that the shores under the beams do not have to be removed at all when taking down the slab panels. The shores should never be removed until the concrete is so hard that it is impossible to drive a 10-d. nail into the concrete and there should be at least 30 das. when the temperature of the concrete is above 45° before the shores are removed. This temperature, of course, can be obtained artificially if necessary.
9. In re-shoring, care should be taken to put a cap at least 2' long and 4" wide on top of the shore to distribute the load, and, in the case of concrete and tile or similar construction, this cap should be so placed that it bears on one or more ribs and in no case should it bear entirely on the tile, for, in the latter case, the tile will crush and cause the supporting floor to fall.
10. Care should be taken to place a sill under all shores and especially in case of a tile and joist or similar construction where thin concrete members occur, these sills should be so placed that they will distribute the load over the joints in a tile and joist construction.

An additional suggestion which Mr. Anderson makes is as follows:

No cement should be used until it has been tested for soundness and fineness and for tensile strength at 1 da., 7 das. and 28 das.

Some Notes on Wear of Chevy Chase Road

The manner in which cracks have developed in the concrete road laid without expansion joints by the U. S. Office of Public Roads at Chevy Chase, Md., supplies interesting study; details of the crack development are indicated in the accompanying table. The examination of the concrete which is not covered with any bituminous material is much more satisfactory in the study of the cracks, and it will be noticed from the table that the gravel concrete has developed cracks at an average distance of 61', and that the gravel concrete made with oil in the mixture developed cracks every 45'. The

AVERAGE DISTANCE BETWEEN CRACKS ON CHEVY CHASE EXPERIMENTAL ROAD

Surface Coated with Bituminous Materials			
Concrete	Aggregate	Length Feet	Av. Distance Bet. Cracks
Plain	Gravel	660	45'
Plain	Limestone	580	145'
Oil-Cement	Limestone	230	113'
Oil-Cement	Gravel	370	50'
Surface Exposed			
Plain	Gravel	425	61'
Plain	Limestone	600	100'
Oil-Cement	Limestone	210	105'
Oil-Cement	Gravel	260	45'
Oil-Cement	Trap	290	60'
Plain	Trap	300	40'

striking thing is the fact that the limestone concrete is the most nearly free from cracks.

Information as to this road construction has been published in this magazine, as follows: Specifications for work, Sept., 1912, page 52, and further specifications, Dec., 1912, page 64. Measurement of expansion and contraction, Jan., 1913, page 31, and details of the construction methods, Sept., 1913, page 100.

Early in December it was noticed that the bituminous coating on a considerable stretch of the road was beginning to peel, more particularly in the strip adjacent to the gutter on the west side of the roadway, while it remains in good condition, with very few exceptions, on the other side of the roadway. In this connection it should be mentioned that the high part of this pavement is not in the center, but is on the east side next to the electric railway tracks, and that it slopes from that side to the gutter on the west. The wear of the bituminous coating is coming on the side taken by the traffic going into Washington, and it is pointed out that the traffic going into Washington is undoubtedly heavier than that going out. Still, the worst peeling is so far over towards the edge, near the gutter, that it is doubtful that the peeling is due to actual wear. Logan Waller Page, director

of the Office of Public Roads, writes CONCRETE-CEMENT AGE: "I think the ironing effect of the traffic near the center of the roads has tended to buckle the tar on the west margin. As soon as it is at all loosened from the concrete surface, water has a maximum effect on account of drainage being in that direction."

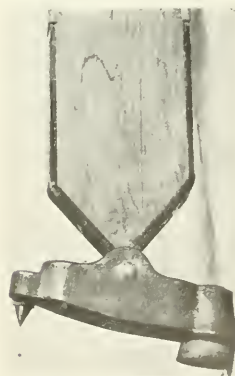
Another possible influence on the situation is the fact that during construction, it is just possible that if the concrete surface were any less clean on one side or the other when the bituminous coat was put on, the dirty side would probably be the low side, to which particles of dust and dirt might have been washed.

A Safety Ladder Foot for a Concrete Floor

Concrete floors are hard and smooth and do not offer much foothold for a ladder. To avoid accidents from ladders slipping on concrete floors the Eastman Kodak Co., Rochester, N. Y., has designed a ladder base as shown in the accompanying illustration.

This base is made of cast-iron and at one end rests on a rubber pad and at the other end on a spike. The spike will hold on wood or dirt surfaces, while the rubber holds on surfaces where spikes would slip, such as concrete, composition flooring, etc.

This produces a safety foot for the ladders which will not slip on any floor and which needs no adjustment. For the spikes, threaded horseshoe calks, of a type easily purchased in the open market, are used. The rubber pads are standard large-size crutch tips. The suggestion may be of interest to plant managers who have trouble with slipping ladders.



A SAFETY LADDER FOOT DEVELOPED BY THE EASTMAN KODAK CO.

In the above illustration A shows the horseshoe calks 3/4" long; B a rubber crutch tip 1/2" thick



FIG. 1—A CONCRETE BRIDGE IN FAIRGROUND PARK, ST. LOUIS

Concrete Bridges in St. Louis Parks and Some Cost Figures

When the city of St. Louis acquired Fairground Park a few years ago, the plans for the park called for a long body of water crossed at two places by concrete arched bridges. The plans for these two structures, identical in every way, were drawn up later, calling for a 40-ft. span and 11' of clearance between the surface of the water and the crown of the arch.

These bridges were built by the construction division of the Park Dept., under the supervision of Nelson Cunliff, at a cost of \$5,300 apiece. The bridges are 18' wide and 118' long over all. The endeavor was made to have them examples of architectural design that would harmonize with the entire lay-out of the park.

The crown of the arch ring is 11" thick. The bridge throughout was reinforced with cold-twisted high carbon steel bars. The concrete in the arch was a 1:2:4 mix composed of Portland cement, Meramec river sand, and 3/4-in. limestone.

The formwork was so arranged that all the concrete was poured directly in place and no troweling or tool work was necessary after the forms were removed. The moldings were formed by using inverted wooden shapes built up of members furnished by the mill. The concrete on these bridges was all mixed by hand.

The cost of construction was as follows: Excavation, \$123; reinforcing, \$560.35; concrete, \$1,968.50; finishing, \$1,853.98; steps and walks, \$650; supervision, \$115; total, \$5,270.83.

The cost of the grading and removal of excavation and removing the old structure was \$829. The cost of the retaining walls and abutments

was \$1,173.20, making a unit cost of 20 cts. per cu. ft.

The cost of the slabs and beams, including form work, all reinforcement, concrete, labor and materials, was \$1,842.27 or 63 1/2 cts. per cu. ft. The cost of the overhang, including moldings and extra form work, was \$254.80 or 77 1/2 cts. per cu. ft. The balustrade cost \$458.56 or \$1.19 per cu. ft., making a total cost for the structure of \$4,557.83.

Dwight E. Davis is Park Commissioner; Nelson Cunliff, as supt. of the construction division of the Park Dept., was directly responsible for the design and execution of the work.

Extensive Railroad Concrete Work at Pittsburgh

The Pennsylvania Lines, west of Pittsburgh, are spending \$2,000,000 on improvements along the right of way through the lower part of the North Side, Pittsburgh (old Allegheny). A freight depot and warehouses that will cover two city blocks and will be the biggest establish-

ments of this kind in western Pennsylvania, are being erected. The John F. Casey Co., Pittsburgh, is doing the ground work, which entails both excavating and filling. The retaining walls and foundations are be-



AN INGENIOUS CONCRETE PLANT ON HEAVY CONSTRUCTION WORK IN PITTSBURGH

ing constructed of concrete. This work will cost \$500,000. The following figures are supplied by the company: Excavation, 12,000 cu. yds.; piling, 45,000 lin. ft.; concrete, 8,000 cu. yds.

Machinery used consists of 1 locomotive crane, 3 small 1 1/2-cu. yd. concrete mixers and 1 1-yd. concrete mixer; 3 derricks.



FIG. 2—STEEL REINFORCEMENT IN PLACE. CONCRETE BRIDGE IN FAIRGROUND PARK, ST. LOUIS

New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

A New Way of Attaching Screw Anchors

Inserts that can be used in the forms have become an important detail in concrete structures because a little consideration in locating inserts on the plan does away with an immense amount of costly drilling when the structure is completed. Some architects stud factory ceilings and side walls with inserts at the corners of a square 2' or 3' on a side

to the tensile strength of the bolt. The head of the bolt may be countersunk as shown in Fig. 1, or flush with the surface, Fig. 2. The second method requires a shallow auger hole in the form; never more than 9/16" for a 1-in. bolt, so that no injury is done to the forms. The entire fixture may be countersunk by using a

Mushroom Ventilators for Concrete Floors

The problem of thoroughly heating, cooling and ventilating theatres, churches and auditoriums is most successfully and practically met by admitting fresh, warm air to the room through a proper device inconspicuously placed under the seats. The "A B C" mushroom ventilator¹ is so constructed as to be capable of regulating the quantity of air at the points where the air is delivered and compelling the air to flow evenly in all directions, thus preventing

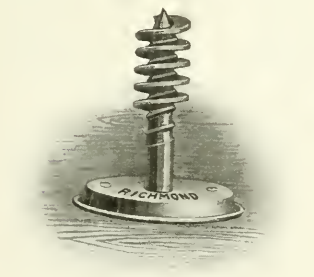


FIG. 1—A LIGHT SCREW ANCHOR HELD IN PLACE WITH A METAL DISC

over the entire area so that shafting and other fixtures may be readily attached at any time. These inserts are usually of cast iron and can be nailed to the forms; when the forms are removed the metal face of the insert shows at the surface of the concrete.

The illustrations show a steel spiral insert² that has been on the market for some time, but the metal clamps for nailing the bolts to the forms are a new feature. The spiral anchorage can be located at any depth from the concrete surface, thereby giving any holding power up

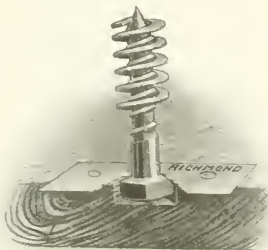


FIG. 2—SCREW ANCHOR WITH HEAD SET INTO FORMS AND HELD IN PLACE WITH METAL PLATE

clamp as large as the base of the fixture. Several bolts may also be accurately set as a unit, the clamp acting as a template. The clamps are of thin metal and can readily be punched to order.

The small size of this insert makes it almost ideal for complex reinforcement, as it will readily fit between the reinforcing rods.

Charles H. Eglee, for nine years Gen. Mgr. of the Ambursen Hydraulic Const. Co., Boston, has just become connected with the Aberthaw Const. Co., Boston, and will have charge of all dam and reservoir work for this company.



draughts or strong air currents and affording the uniformity of ventilation required in a perfect system.

This ventilator is made of cast iron and consists of two parts, the head and the thimble. The adjustment of the head as to height is made by simply turning the head. The head has a smooth surface, having no depressions for outside regulating devices. By the adjustment of the head any quantity of air desired can be delivered and the head being then locked in position always insures the

²Richmond Screw Anchor Co., Pulitzer Bldg., N. Y. C.

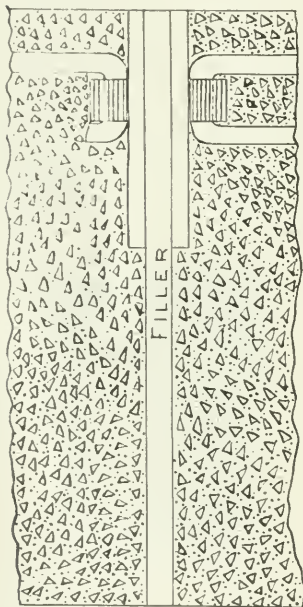
¹American Blower Co., Detroit

same volume, no more and no less. When closed the head rounds off but little above the floor and offers no obstruction to cleaning the floor.

The thimble is made the thickness of the floor in which it is to be placed. When the building is being constructed, the thimbles are properly located before the concrete is poured and the heads placed later. The thimble of this ventilator does away with galvanized iron sleeves through the floor or forms for construction purposes.

New Plate for Pavement Joints

The accompanying cross-sectional view shows the use of a new protector plate for the joints of concrete paving, manufactured by the Puffer-Hubbard Mfg. Co., Minneapolis. As originally designed, loops were



punched out of the plates. These were depended upon entirely to give bond to the concrete at the end of each section. The development of the plate, however, has resulted in the use of both single and double loops, as shown in the illustration. Either loop is furnished as desired. The double hook is shown on the right and the single on the left. These plates are manufactured with curves to conform to the crowns of the various jobs for which they are intended.

A New Type of Reinforced Concrete Pole

The increasing demands of the telegraph, telephone, light and power companies and the rapid progress of electric traction, together with the increased scarcity of suitable timber poles, have compelled engineers to seek a suitable substitute possessing the desirable qualities of wooden poles and eliminating the necessity of continual maintenance and frequent renewals. The accompanying



FIG. 1—GENERAL VIEW OF THE "STAR" REINFORCED CONCRETE POLE

illustrations show a type of reinforced concrete pole which has been developed by W. H. Lienesch, cons. engr., Chicago, and Chas. J. Aschauer, Decatur, Ill. In cross-section this pole is essentially a com-

pact, equal-armed cross. As a trade name, the term "Star" pole has been adopted. Concrete webs are introduced at definite intervals and staggered, affording an adequate brace for the four exposed stems of the cross, and developing what should be approximately the equivalent of a solid square pole of the same gross cross-section. The pole is designed to develop the maximum of rigidity with the least amount of concrete and, consequently, of the least weight. The steel reinforcement is intended to be fabricated and the pole is manufactured in metal pressure molds.

A point of interest to note here is the fact that such a pole can be easily climbed.

A pole of this type, the inventors state, weighs only $2/3$ as much as a square concrete pole of equal strength, and it is planned to manufacture this pole at central plants, shipping them into the field as needed.

Trade Publications

Clip-Bar, Galvanized Curb Guard. Clip-Bar Mfg. Co., Philadelphia, 9" x 6", paper, 4-pp. folder, illust. This catalog presents essential features of a "Clip-bar" corner guard which is essentially a steel bar $3/4$ " thick, $2 1/2$ " wide, rolled to a quadrant with a 1-in. radius, and the edges turned in to provide anchorage. Specially shaped clips are used to tie the guard back into the mass of concrete.

Cement—Best Bros. Keene's Cement Co., Medicine Lodge, Kans., 9" x 5" paper, 28 pp. This booklet describes in detail what Keene's cement is and how it is made, differentiating especially between Keene's cement and hard wall plaster. Complete specifications for plastering, ornamental work, finishes, etc., are published. There is also quite a little useful information on painting over Keene's cement, on cost of materials and labor, etc.

Concrete Products for Railways—C. F. Massey Co., Chicago, 6" x $3 1/2$ " paper, 32 pp., illust. This is an interesting little booklet describing in detail the essentials of good reinforced concrete pipe manufacture, designed especially for railroad use. Portable telephone booths and switchmen's houses are also described.

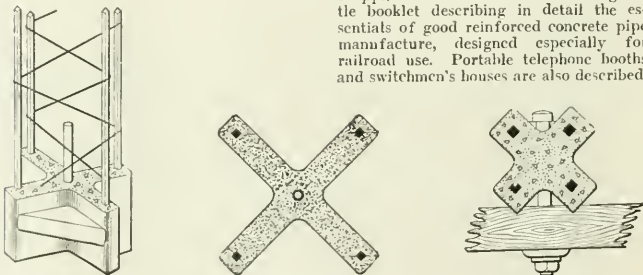


FIG. 2—STRUCTURAL DETAILS OF CROSS-SHAPED POLES, SHOWING THE FABRICATED REINFORCEMENT, CROSS-SECTION AT THE BASE, AND A CROSS-SECTION AT THE TOP WITH DETAIL OF CROSS-ARM

Concrete-Cement Age

Vol. 4.

March, 1914

No. 3

The Chicago Cement Show

IN our concrete field each year brings great development and greater promise. The annual shows, in this, as in other industries, not only measure what has been done in years past, but are a promise of the activities of the coming year. The progress of an industry can well be measured in terms of the equipment and materials with which it works, and at the Cement Shows—which might well be called Concrete Shows—the man active in concrete work, the builder, the engineer or architect, can acquire in the shortest possible time a great amount of valuable information.

Such a Show is in reality a market and a school-room. New things can be learned of centering methods, of mixing equipment, of concrete products equipment, of hand tools and power equipment, and men come to learn and to buy.

The Seventh Chicago Show—from Feb. 12-21—and held as usual at the Coliseum, was a decided success from nearly every standpoint. The exhibits were comprehensive and well handled, the attendance was uniformly good and well sprinkled with men ready to place orders. While the "volume" of the Show, in exhibits and attendance, did not impress one as being so large as in some of the Shows of past years, yet the individual quality and earnestness of exhibitors and visitors was apparently better than ever before.

The men producing the equipment and materials with which an industry works are an essential part of the industry. What should we do, for instance, if we had no concrete mixers or wheelbarrows? A Cement Show is a great big informal gathering for one definite purpose—getting acquainted. Immediate sales develop, of course, but getting acquainted is the important part. From both standpoints, the Show just past was successful.

Ten Years—and Tomorrow

JUST in passing, we mention that the present issue of this magazine takes us into our eleventh year of publication. *Concrete* was first issued in March, 1904; *Cement Age* was first issued in May, 1904; *Concrete Engineering* was first issued in Jan., 1907, and for nine months was issued twice

a month, then as a monthly, completing four years before its consolidation with *Cement Age* in Jan., 1911. Then came the next consolidation in July, 1912, embracing all three magazines. This March, 1914, number is our 276th issue. In these are summed up more than 22 unit years of editorial effort. We are gaining in experience and we are trying to serve you a little better each month than we were able to do the month before; and in this service we are trying to give we are not unmindful that we owe much to the leaders and the pioneers and the individual solvers of the detail problems of the field. After all, what CONCRETE-CEMENT AGE is able to do in the way of service is really in the capacity of a responsive central bureau for the field—its service is a mutual service among our individual correspondents and friends. Through their continued co-operation we shall be able to improve the quality and the extent of the service of this institution.

The American Concrete Institute

THE Ninth Annual Convention of the American Concrete Institute, formerly the National Assn. of Cement Users, held in Chicago last month, marked nine years' consecutive work of gathering, co-ordinating and spreading a better knowledge of concrete. Considering the difficulties which the Institute has had to face, the financial handicaps, etc., the convention at Chicago was well attended. The program of papers offered was not so comprehensive as it might have been, but the very excellent reports of the committees who had worked hard and to good purpose, made the program as a whole of great value.

The publication of a monthly journal has put new life and energy into the rank and file of the Institute and into its officers, and from now on, it looks as though this Association were really going to fulfil its promise of becoming a great Association, great in name and in work, standing for the best in concrete development the world over, and meeting the need for more definite, practical and technical information on concrete.

It must be admitted, with regret, that in the last few years, the rank and file of men handling concrete have been content to let the burden of the

Institute fall on a comparatively small group of men, who have had to shoulder all the responsibility, financial and otherwise. The work of the Institute, making for better understanding and application of concrete, is, directly or indirectly, of real value to every man handling concrete. It can not be otherwise, and the Institute should have the active support of every man in the field. From now on, this work of the Institute is going to be brought before every possible man handling concrete in any way, and every man reached is going to have the opportunity to co-operate by bringing his work and support to the work of the rest.

The last convention is, we feel, the last of the meetings with meagre attendance, and a support not general. The committee reports submitted and discussed at that convention are an indication of the spirit of the work, of what can and will be done, by the American Concrete Institute. Definite plans are under way which will make this Association the factor it ought to be in the better development of America's concrete industry. And from now on, the Institute goes forward, aggressively and actively, to a greater field of usefulness, serving the industry as a whole.

Exchange of Ideas Essential to Progress

THE circular issued by the Cement Products Exhibition Co., announcing the last Chicago Cement Show, begins with the sentence: "The guilds of the Middle Ages jealously guarded their trade secrets, and building knowledge was a possession of the few." The circular then goes on to recite how different present conditions are, and how the present high standards of design and construction and wider knowledge of building methods have been attained largely through the generous interchange of ideas among architects, engineers, builders and laymen. This is so apposite, just and clear that the case should not be permitted to pass without noting how well it reflects the present condition of the concrete industry and that without this wide distribution of knowledge of building methods, road construction methods, bridge construction methods and in fact without this wide dissemination of knowledge of all that pertains to the

use of concrete it is a grave question whether or not the development of the industry that has taken place would ever have come. Certainly in this field our country is in the forefront, and it is largely to the exchange of information and to the open minds that have received it that we owe the great development of the American Portland cement industry and the great extension of concrete construction in all parts of our country.

The 1914 Outlook

SOME fears are expressed that the coming year may not be so large a one as 1913 so far as the consumption of cement is concerned. There may be some reason in this so far as the building industry is concerned, especially in large cities. Office rents, mill rents, house rents and apartment rents are all fixed upon a certain return upon the capital invested, and of late years many buildings of all these classes have been erected with money ranging from 4% to 5% so far as first mortgages are concerned. The high rate for money ruling in 1913 certainly put a damper on construction generally so far as the projecting of large buildings was concerned. No one would undertake to plan for 1914 an apartment house to be built with 7% or 8% money, which when erected was to compete in rentals with other similarly situated apartment houses built with 4% or 5% money. This fact has had a retarding influence in certain quarters, while the delays in giving the railways an advance in freight rates has also held up much projected railway construction. However, the clouds over the railroads are likely soon to blow away and the immense development in concrete roadways, concrete sewers, concrete bridges for municipalities, counties and states is likely to furnish new fields to make up for some of the possible loss in the field of building construction.

The Road Conference

THERE can be no doubt that the first National Conference on Concrete Road Building was a success. It brought together into a forum a great deal of the best thought that has been given to concrete road

construction. It brought together so much matter that its only weakness was in the limited time for discussion. The 15 committees handling the various sub-topics of the general subject of concrete road building presented so much good material at the well-attended meeting in Chicago that we feel that it will be better to publish considerable matter in later issues than to condense the proceedings to meet the space limitations of a single issue. A second conference, which undoubtedly will be held, is desirable because a second conference will have a good foundation upon which to proceed.

Fire Loss and Concrete Buildings

FIRE Loss Lower in 1913," announces the New York Sun, and follows it up by stating that not in four years has the damage to the country been so small. Whether or not there can be any correlation between this diminished fire loss and the increased cement consumption CONCRETE-CEMENT AGE cannot say, but it certainly does seem that the student of fire statistics might find some lines parallel between these two facts. The growth of concrete building, which means fireproof construction, has been stupendous and the diminution of fire loss when considered in connection with the enormous growth of building construction in this country may very possibly be attributed to the increased rate of concrete construction.

New Name for Old Paper

THE Germans are nothing if not thorough, and when they do things seldom do them by halves. Our estimable contemporary, that important German paper which represents the Assn. of German Portland Cement Mfrs., and rejoiced until Jan. 1 of this year in the title, "Mitteilungen der Centralstelle zur Forderung der Deutschen Portland-Cement-Industrie," has seen fit to change its cognomen, and with the qualities above described, it has slightly abbreviated its elongated title to the plain, ordinary, simple and unvarnished term, "CEMENT." Under the new and clear name it will have the esteem and support of all who admired it under its old title.

Some Notes on Railway Construction Work, with Unusual Features, Near Cairo, Egypt

By E. HARRAN¹



FIG. 1—GENERAL VIEW OF THE APPROACH WORKS, G'ANGERS' CAMP, BALLAST TRAIN AND PIER TOPS, OF THE EGYPTIAN DELTA RY. BRIDGE BEING CONSTRUCTED NEAR CAIRO, EGYPT

Bringing sand by camel-back, sand-lime brick piers and concrete pipes cast by an ingenious method are some of the interesting features of the following notes on railroad work in Egypt.

The 75-cm. (29 $\frac{1}{2}$ ") gauge single line of the Egyptian Delta Light Ry. has hitherto crossed the 4' 8 $\frac{1}{2}$ " standard gauge double lines of the Egyptian State Rys., Cairo-Port Said Section, at Benha, 40 kms. (24.86 miles) from Cairo, at right angles on the level. With the increase in the number of trains running, this was inconvenient to both systems, and arrangements were made to divert the light line and carry it over the broad-gauge lines by means of overhead crossing. Work was started in July, 1913, and is expected to be completed early in 1914.

As there was no earth available for filling at the site, the fill for the approaches has had to be hauled an average distance of 6 kms. (3.72 miles) from the Rayah-El-Tewfikieh canal. Two ballast trains, each composed of 18 10-ton carrying capacity trucks, have been employed, making an average of 11 trips a day

each. Up to the middle of September 70,000 cu. m. (91,556 cu. yds.) of earthwork formation had been done. The embankment so formed will be 4 m. (13.12') wide at the top, with 2:1 side slopes, and 9 m. (29.52') high at the bridge. The length of the south approach is 790 m. (2,592'), on a 0.66% grade, the radius of the sharpest curve being 170 m. (558'). The length of the north approach is 922 m. (3,021') on a 0.66% grade also, the radius of the sharpest curve being 180 m. (590').

*PLASTERED CULVERT PIPE WRAPPED WITH CANVAS

Large use has been made of concrete and cement. There are 250 m. (820') of culverts, 50 cm. (16.4') in diameter, constructed in reinforced concrete, and 40 m. (31') of culverts 2 m. x 2 m. (6.56' x 6.56') constructed with the same material. The concrete is Gillingham Portland cement and sand mixed 1:3, the reinforcing elements being steel rods $\frac{1}{2}$ " in diameter and flat steel wire.

In all works in Egypt where embankments and other structures are erected in the country the matter of keeping the numerous irrigation water courses open to free flow is one of importance. This is usually attained, as in the present instance, by the use of pipes of varying diameter constructed of reinforced concrete. In the case of the culverts for the bridge the pipes are from 3 m. to 5 m. (9.84' to 16.40') in length.

The pipes are made in a local factory and the method of construction is as follows:

Cores are made of the diameter of the pipes required, iron rings being placed at each end with longitudinal steel rods running the length in between. Flat steel wire is then twisted spirally from end to end around the rods. The cement and sand mortar is then applied, the core being revolved the while. When completely covered with the mixture a strip of canvas, about 4" wide, is wrapped around and around the pipe to keep the plaster in shape. This is removed after the process of setting has advanced. The core is removed and the pipe placed to set in a special shed in which a thin spray of water plays upon it continually, to develop slow setting. The pipes are perfectly straight and when laid for use the joint is made by a ferrule about half a metre (19") in length and of a slightly larger diameter than the pipes, the space being ce-



FIG. 2—THE SAND FOR THE CONCRETE ON RAILROAD WORK NEAR CAIRO IS BROUGHT BY CAMEL BACK

¹Asst. Mgr., Egyptian Delta Light Rys., Ltd., Cairo, Egypt



FIG. 3—VIEW OF THREE OF THE PIERS BEING BUILT ON CONCRETE FOUNDATIONS OF SAND-LIME BRICKS WITH ARTIFICIAL STONE QUOINS

mented up by hand to make it watertight.

LABOR CONDITIONS IN EGYPT

In use, the pipes are laid by hand labor, which also is used to mix and handle all concrete used in the work. Often even in very large works, concrete mixing machines are not used. Unskilled labor is cheap in Egypt, the usual wage paid to a laborer being 29 cts. a day. Under skilled European supervision, constantly on the spot, it works well.

The sand utilized in all concrete mixtures is ordinary desert sand, of which there is nearly 400,000 sq. miles in Egypt, cleaned and carefully screened. The Abou Zabaal pebbles used are of a black basaltic stone of volcanic origin, which is taken from quarries, or pockets in the ground, in the vicinity of Abou Zabaal village, in Lower Egypt. It is found nowhere else.

CONCRETE ON THE BRIDGE PIERS

The foundations of the bridge itself are laid in concrete, a 1:2:4 mix, using Portland cement, sand and Abou Zabaal rubble (pebbles) capable of passing through a 6-cm. (2.36") mesh. On these foundations have been erected the piers and abutments of sand-bricks faced with concrete quoins.

The sand-bricks merit description as being something quite peculiar to Egypt.² The basis of their composition is ordinary sand from the desert, well sifted, mixed with a percentage of unslacked lime in large drums and then highly compressed in an atmosphere saturated with steam. This has the effect of slacking the lime and binding the constituents of the brick, leaving a solid block capable of withstanding a compression of some 460 lbs. per sq. in.

There will be two subways through

the earth formation, one for an agricultural road, and one to permit of the passage of a small 2-ft. line of private agricultural railway serving an adjacent estate, the property of a princess of the Khedivial family. Both will be constructed of masonry embedded in cement.

The bridge itself, which will span the Egyptian State Ry. main Cairo-Port Said line, a road and an irrigation canal, will consist of two box girders 75 cm. (2.46') deep, and longitudinal steel sleepers, with a foot gangway on each side 1.5 m. (4.92') wide. The central span is 8.20 m. (26.90') long and gives a clearway of 5 m. (16.40') from broad gauge rail level to underside of girders. The two end spans are 10 m. (32.80') in length each.

The concrete foundations of the piers were put in in 15 days, during which time the State Ry. trains worked over "gauntlet" lines, piles and sheet piling having been driven in to protect the embankment and prevent subsidence.

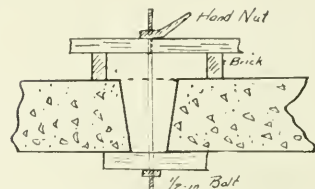
The estimated cost of the whole work, on which about 400 men a day are employed, is £10,000 (\$48,700). The steel work is being made to order and supplied by the Tees-side Bridge and Engrg. Works (England).

Fig. 1 gives a general view of the work, showing the north approach embankment, on which a ballast train is being unloaded, the tops of the piers and the gangers' camp. Fig. 3 shows the piers, the figures in the immediate foreground being Jesse B. Peacock, A. M., I. C. E., A. M. J., M. E., the construction engineer, on the left, and F. Fitzgerald, B. A. I., asst. engr., on the right. This view shows in detail the sand-lime brick piers with concrete forms. In this view, the runway seems to be at a very steep angle, but this is due, probably, to a foreshortened view. The actual angle of the runway is shown better in Fig. 2.

Method for Patching Holes in Concrete Floors

On a reinforced concrete building being constructed in Detroit by the Selden-Breck Const. Co., St. Louis, the centering used is of the continuous type developed by Brussel & Viterbo, consulting engs., St. Louis. In this system of centering the vertical shores are not under the beams, but are grouped in pairs so that a cross piece from shore to shore makes a saddle about 4' long, in which the concrete girder is held. The 4"x4"'s are carried right through the centering and on up so that it is possible to center up several floors without waiting for the steel or the concrete.

When the concrete is poured, a galvanized iron collar around the 4"x4"'s at the floor level makes an inverted cone-shaped hole through which the 4"x4"'s pass. After the



SKETCH SHOWING THE ARRANGEMENT OF BOARD AND BOLT FOR PATCHING HOLES IN A CONCRETE FLOOR

centering is removed this hole has to be filled and on the building in question, G. A. Harwick, the superintendent, developed an ingenious method of doing this.

One man, working above, would lower on a string, through the hole, a 1/2-in. bolt about 18" long, and a helper below would screw the bolt into the center of a 2-in. board about 12"x12", holding the bolt in place with a nut on the bottom side. The man above then pulled up the bolt in the board and held it in place by passing it through a cross piece which was supported on a couple of bricks as shown in the accompanying sketch. The board at the bottom was brought up tight against the ceiling by a hand nut. The hole was then packed with concrete and finished off properly.

The bolt was really a 1/2-in. rod threaded at each end so that when the bottom board was ready to be removed it was only necessary to unscrew the bolt at the top, and the board and the nut below would drop down to be picked up by a helper.

²The author may not be aware that sand-lime brick are in common use in this country—Eds.

A Summary of the Proceedings of the Tenth Annual Convention. American Concrete Institute

The American Concrete Institute held the first meeting of its 10th annual convention Monday evening, Feb. 16, at the Auditorium hotel, Chicago. Following some remarks by Pres. Humphrey, calling attention to the change of name from the Natl. Assn. of Cement Users to the Am. Concrete Institute, the opening address was made by Henry Ericsson, bldg. commr., Chicago, who extended to the Institute the address of welcome in behalf of the contracting interests of the city. The address was marked with witty allusions to various interesting uses of concrete.

Following Mr. Ericsson, an address of welcome on behalf of the architects was delivered by Elmer C. Jensen, pres., Illinois Chapter, Am. Inst. of Archts. Mr. Jensen's address was short and to the point, a message from the architect to the builder—a plea for the best in concrete work.

The address by W. H. Finley, ch. engr., Chicago and Northwestern Ry., Chicago, presented to the convention an interesting summary of an active engineer's acquaintance with concrete, extending over 30 years. Mr. Finley has seen, in construction materials, the transition from wood to iron and to steel, and from stone to concrete. Cement is in reality the most uniform product offered to the builder. Concrete is the help of the engineer.

Mr. Finley pointed out the analogy between cast iron and concrete. Both materials are poured; in both re-entrant angles are dangerous and hard to handle, and both are subject to internal stresses. European engineers, many years ago, anticipated reinforced concrete, by embedding in cast iron structural units bars of wrought iron to take the tensile stresses.

In concluding his address, he described some experiences with bridges, and stated emphatically that he was very glad to see metallic bridges, erected in the last two decades, being replaced with concrete bridges.

In responding to the addresses, Pres. Humphrey called attention to the fact that it might be possible that

the handicaps of concrete construction were due to the conservatism with which engineers had received it. The day is past, however, when failures are blamed on the material. Today, a failure is entirely a reflection on the ability and honesty of the men responsible for the work.

The committee on nomination was announced as follows:

E. J. Mehrin, N. Y. C.; L. T. Sunderland, Kansas City, Mo.; Cloyd M. Chapman, N. Y. C.; A. E. Lindau, Chicago; L. C. Wason, Boston.

The committee on resolutions was announced as follows:

Joshua L. Miner, N. Y. C.; H. B. McMaster, Youngstown, O.; E. S. Hanson, Chicago; A. J. Maynard, Bridgewater, Mass.; W. A. Slater, Urbana, Ill.

CONCRETE PAVEMENTS

R. C. Stubbs, Dallas, Tex., opened the Tuesday morning session with a paper, "Some Requirements in Vibrolithic Concrete Pavement Construction."

Of the two fundamental ideas which Mr. Stubbs advanced, one, which is quite contrary to the belief held by men who are trying for the best results in concrete paving, is that there is frequently a possibility of too much compacting of the sub-grade. While road builders have been preaching energetically the gospel of thorough rolling, tamping and otherwise compacting the sub-grade, Mr. Stubbs has come to the conclusion that various earths of which all sub-grades are made up have normal density, and that it is quite possible, in preparing a sub-grade, particularly in the center of a roadway where travel has been greatest, and where the work of the roller is more apt to be thorough, to get an abnormal density. Mr. Stubbs particularly mentions certain clays which it is very easy to compact to a great extent, although in their natural condition they do not exist nearly so compactly. He declares that the tendency of all these earths is to return gradually to the condition of natural density, and that sometimes this comes in a very short time after the construction of a road, and sometimes in a year or two years. In any event, if this return to normal density is not equal over the entire surface

of the sub-grade, stresses in the concrete covering are bound to result which are apt to produce cracks. He would account in this way for the prevalence of longitudinal cracks in the center of many concrete slabs.

Mr. Stubbs also lays great stress upon the importance of having only just the right amount of water in the mixture of concrete. He points out that in a properly graded mix, where the materials are combined with a proper amount of water, there is practically a voidless concrete. It is quite probable and likely, he says, that an excess of water mixed in the mass will result in voids, inasmuch as when this water disappears it must leave space behind it. To illustrate his point, he suggests an experiment with soap bubbles enclosing them in a granular mass, applying agitation and compression as would be done in mixing and placing concrete. He then suggests trying, by compression, to remove all the bubbles, which he says cannot be done. The big bubbles will make many smaller ones, which will, nevertheless, be equal in volume, and will result in honey-combing, which is, in concrete, severely detrimental.

This opened up an interesting discussion on roads, especially foundation requirements.

Mr. Stubbs was followed by H. J. Kuelling, county highway commr., Milwaukee, who discussed road problems in a practical first-hand manner. He emphasized the fact that first-class materials are essential for concrete work. Gravel must be clean and well graded. Such provisions are always economies. Proportions should be based on the voids in the materials to be used, and not on any pre-determined ratio. Sacks on the Milwaukee work have been handled with very little loss, less than 2% in handling over 300,000 sacks in the past season's work.

As to the expansion joints, the 1914 work is going in with one-half of the work put down with steel protected joints, and the other half without steel plates. Joints are to be run at varying spacings up to 50'.

In protecting new work the wind is considered more dangerous than

the sun, as the drying action of the wind is more pronounced. A bituminous coat will not be used on the 1914 work. Another point of interest touched upon was that every effort will be made to get all concrete work down by Oct. 1, to allow a full month to elapse before cold weather sets in.

Answering a request for some cost information, Mr Kuelling detailed the following costs on over 5,200', practically a mile of 18-ft. concrete highway. For this work, about 10,510 sq. yds., the costs per sq. yd. were as follows:

Gravel and sand at switch.....	\$.275
Shoulders	.035
Hauling	.270
Cement (\$1.65 per bbl.).....	.420
Concrete labor	.1875
Miscellaneous	.010
Joint material (joint=35' o. c.).....	.040
Workmen's compensation	.030
Machinery depreciation	.030
	1.2975
(Assume)	1.30

Including other items the cost came up to \$1.54 per sq. yd.

A valuable paper on "Expansion and Contraction of Concrete Roadways," by Rudolph J. Wig, assoc. engr. and physicist, Bur. of Standards, Washington, D. C., closed the morning session, except for the discussion of paving specifications. Mr. Wig's paper was a digest of his report as chairman of the committee on Contraction and Expansion of Concrete Roads of the National Conference on Concrete Roads and is published in part in the account of the proceedings of the Conference elsewhere in this issue.

C. W. Boynton, chairman of the committee charged with the preparation of standard specifications for concrete road construction, presented a report of the committee, and it was opened up, paragraph by paragraph, for discussion. Much of the discussion centered around the specifications for fine aggregate. The committee's recommendation was that a fine aggregate should pass, when dry, a screen having 14-in. openings, that not more than 15% should pass a sieve having 50 meshes to the lin. in., and that not more than 2% should pass a sieve having 100 meshes to the lin. in. It was frankly conceded in the course of the discussion, that while in general fine materials in excess do not make for good concrete to stand abrasive wear, there are in some localities materials of excellent quality for road building which have considerably more than 15% of material which would pass a sieve having 50 meshes to the lin. in. The statement was made that the requirements proposed by the committee would practically elimi-

nate 90% of the fine aggregate in the Chicago market.

The discussion of fine sands led to the discussion of stone dust. Percy H. Wilson, secy., the Assn. of Am. Portland Cement Mfrs., said that while limestone dust increased the strength in compression of concrete, it makes a very bad material for a concrete road, and yet a Chicago builder said that he had constructed several roadways and drives of concrete using limestone dust with excellent results. Attention was directed, however, to the very wide difference through the country in the quality of limestone and that in specifying such material its nature should be noted.

In connection with the discussion of bank-run material it was pointed out by E. S. Larned that contrary to the belief of many contractors it is not economy to use bank-run material. There are so many cases in which cement is actually wasted from lack of knowledge of cement required for a given material, that more cement is used than is necessary. Mr. Larned said that it was a positive fact that in the long run, money could be saved by the contractor in learning the nature of the material, screening, and using proper amount of cement.

Returning, however, to the percentage of fine material passing the No. 50 sieve, the specifications in this regard were finally changed so that not more than 20% shall pass a No. 50 sieve, and not more than 5% shall pass a No. 100 sieve.

One peculiar feature of the adoption of this requirement by the American Concrete Institute is the fact that in the Recommended Practice adopted by the National Conference on Concrete Roads the last item recommends the standard Specifications for Pavements and Roadways of the American Concrete Institute, and yet the Conference in laying down the requirements for aggregates said that not more than 15% of the aggregate shall pass a No. 50 sieve and that not more than 2% shall pass a No. 100 sieve. Even this requirement by the National Conference was a concession to the practical conditions of the field, inasmuch as the report brought in by the committee of which Sanford E. Thompson was chairman, recommends that not more than 10% of the fine aggregate should pass a No. 50 sieve.

REINFORCED PAVEMENTS

The paper on "Reinforced Concrete Roadways and Pavements," by

B. S. Pease,¹ discussed in general the problem of reinforcement for concrete roads. This paper started quite a little discussion, centered mainly around the position of the reinforcement. There seems, at present, very little comprehensive information on what should be standard practice in paving work, and so far, opinion of any value must be based on past experience. Then, too, practice in the past has been hardly more than experimental work.

The convention finally adopted the clause in the pavement specifications covering reinforced concrete work, which had been held over from the afternoon session. This is covered in detail in an abstract of the specifications published in a later issue.

EXTENSIVE TESTS ON TILE

Under the direction of engineers representing the Dept. of Agriculture, the Reclamation Service and the Bur. of Standards, an extensive series of tests is under way to determine in detail the effect of alkali soils on concrete tile. A progress report in this work was made by Rudolph J. Wig, Bur. of Standards, Washington, D. C., who described in general typical cases of alkali disintegration and the program of the tests. At Armstrong, Ia., 10,000 drain tile have been made, using wet, semi-wet and dry concrete. In the fall of 1913, these tile were placed in typical alkali localities in Utah, Idaho, Montana, Arizona and Colorado. About 1,000 ft. of tile were placed in each locality. Careful analyses of soils and ground waters have been made. The test will extend over 10 yrs., sections of the tile line being taken up every year. This work apparently promises some very interesting information.

THE PRESIDENT'S ANNUAL ADDRESS

The Tuesday evening session opened with the annual address of the president, which was a comprehensive review of engineering work in concrete, with particular emphasis on hydraulic construction, such as docks, lighthouses, pile foundations, breakwaters, etc. In discussing the action of sea water on concrete, Mr. Humphrey mentioned some blocks of concrete which had been cast by the French at Panama in 1886. These blocks have been lying on the sea coast and the waves have worn the rocks smooth and round, with no apparent effect on the concrete.

¹Engr., Reinforcement Dept., Am. Steel & Wire Co., Chicago

CONCRETE IN RAILROAD WORK

The wonderful way in which the D. L. & W. R. R. has used concrete for bridges, stations, towers, culverts and retaining walls was next presented in an interesting paper by A. B. Cohen, Engrg. Dept., D. L. & W. R. R. Concrete, as Mr. Finley had stated the previous evening, was truly the "engineer's helper." From artistic switch towers, to great viaducts, reinforced concrete, in the hands of the Lackawanna engineers, has produced wonderful structures.

The Wednesday morning session was a joint meeting with the Interstate Cement Tile Mfrs. Assn., and an account of the proceedings will be found elsewhere in this issue.

RIBBED METAL LATH AS FORM WORK

The Wednesday evening session was opened with a paper by J. E. Payne,² on "Modern Concrete Roof Without Forms," which discussed principally the uses of a ribbed mesh or metal lath in reinforced concrete roofs. This paper, with the paper by T. W. Murray³ on "Combination of Reinforcement and Forms in Concrete Construction" opened up an interesting discussion on the uses of ribbed metal lath in concrete structures. The discussion was based mainly on the question of the position of the mesh within the stucco or plaster coat, and whether or not the metal lath should be painted or galvanized.

P. H. Bates, chemist, Bur. of Standards, Pittsburgh, presented a most interesting paper, embodying a report on investigation made to determine the properties of Portland cement containing a high percentage of magnesia.

A progress report on the condition of the concrete prisms suspended in sea water in Boston Harbor, was made by L. C. Wason, Boston. This report will be presented in a subsequent issue of CONCRETE-CEMENT AGE.

STEEL FORMS AND CONTRACTORS' PROBLEMS

That steel forms have become an important factor in concrete construction work was demonstrated in a paper by C. D. MacArthur⁴ on "Steel Forms in Concrete Construction." This paper, after presenting a general summary of the underlying factors in economical centering work, described briefly the many and varied uses of steel forms. The paper was well illustrated with lantern slides.

In discussing this paper, Mr. Wason brought forward some interesting cost data on concrete form work. In this discussion the speaker emphasized the need of careful planning in form work, and stated that comprehensive form analysis and the preparation of careful details reduced form cost about 75%.

The evening closed with the paper by Mr. Wason on "The Problems of the Contractor." This paper, abstracts from which have been published in these columns in past issues, sums up some of the often-forgotten minor points of contracting work. Many suggestions of value were embodied in the paper.

ELECTION OF OFFICERS

The Thursday morning session was opened by a report of the secy., Edw. E. Krause, reviewing briefly the past year's work and making recommendations for the coming year. This was followed by a report of the Committee on Nominations, who submitted for election the following officers:

President—Richard L. Humphrey, Philadelphia;
Vice-President—Leonard C. Wason, Boston;
Treasurer—R. A. Cummings, Pittsburgh;
Directors as follows:
Second District—E. D. Boyer, N. Y. C.;
Third District—R. W. Lesley, Philadelphia;
Sixth District—John D. Leonard, San Francisco.

The report of the committee was secured and endorsed by the convention. In accepting the presidency, Mr. Humphrey stated that this coming year would be his last term of office.

INVESTIGATIONS OF CONCRETE COLUMNS

The report of the committee on Reinforced Concrete and Building Laws, submitted by A. E. Lindau, chmn., Chicago, described the work of this committee in carrying out the program of experimental work developed at the convention in N. Y. C. in 1910. This work has been directed mainly to co-ordinate and develop data on reinforced concrete which would be of value in formulating efficient building code legislation. The extensive analytical tests on completed buildings have been conducted under the direction of this committee.

Mr. Lindau described the series of tests on reinforced columns. A synopsis of this schedule of tests has already been published in the Dec., 1913, issue of the Institute *Journal*, and Mr. Lindau made frequent reference to this in his report.

This subject of columns brought out some interesting discussion of the relative value of circular or octagonal hooping for columns.

UNIFORM NOMENCLATURE

This committee had no report to make, owing to the fact that through some misunderstanding no chairman had been selected until too late to accomplish anything in time for the convention. F. C. Wright, N. Y. C., is now chairman, and a progress report will be published in an early issue of the *Journal*.

DEVELOPING ARTISTIC CONCRETE

At the opening session already referred to, Mr. Jensen's address was in a way a challenge to the concrete builder to develop concrete structures more architecturally beautiful. A lull in the Thursday morning's session was taken advantage of by O. R. Parry, Philadelphia, to state that the responsibility for the artistic development is primarily "up to" the architect, who should interpret concrete design sympathetically to bring out its best uses. Many possibilities in the beautiful uses of concrete and other materials were pointed out.

TESTS ON REINFORCED CONCRETE BUILDINGS

Burtis S. Brown, Boston, described a test on large sized specimens of flat slab floors made to determine the comparative efficiency of different types of reinforcement. A large slab, approximately 64'x64', supported on short, heavy columns, was built. Different column head designs were used, and the rectangular slabs were reinforced in several different ways. Information of engineering value was developed.

W. A. Slater, Engrg. Experiment Station, Univ. of Illinois, Urbana, made a preliminary report on the test of a new factory for the Shredded Wheat Co., Niagara Falls, N. Y. The following notes summarize the work:

This building is of reinforced concrete construction, using flat plate floors. The building is three stories in height, and the floors are divided by columns into panels 20' x 22'. The test was made on the first floor above the basement story. This floor is 7" thick in the central portion of the panel, is 9" thick throughout the area of 8' 6" x 8' 6" surrounding each column, and is designed to carry 125 lbs. per sq. ft. live load. The columns are octagonal in shape, those of the basement story being 25" in the short diameter and ending at the top in 3' 6" x 3' 6" flared heads. The columns of the story above are 23" in the short diameter. The reinforcement, all of which is placed in the two directions parallel to the sides of the column, is designed to resist positive moment at the centers of all spans and

²General Fireproofing Co., Youngstown, O.

³Trussed Concrete Steel Co., Detroit

⁴Blaw Steel Constr. Co., Pittsburgh

negative moment at the columns and across the edges of all panels.

Originally nine panels were loaded to 191 lbs. per sq. ft. after which the load was removed from six panels, leaving three adjacent central panels loaded. These three panels lie in a row and are one span removed from all but one panel, the central panel of the entire test area and the load on this panel was increased to 243 lbs. per sq. ft.

Deformations were measured at 288 gauge lines and the results were very consistent among themselves. It was found that the condition of the three adjacent panels loaded gave steel stresses at the center of the span more than 50% greater than with nine panels loaded, and that the stress at the support was about 20% less with three panels loaded than with nine panels loaded. It seems apparent that the tendency of the floor to deform as a cylinder instead of as a saucer, its action as a continuous beam, and the lateral distribution of stress to be unloaded portions of the slab, all contributed to these differences between the stresses under nine-panel load and those under three-panel load. The results of the test seem to check the conclusion arrived at analytically that the greater portion of the unbalanced moment was carried by columns and very little by the slab. This conclusion is somewhat in conflict with the observation that there was so great an increase in the stress at the center of the panel when only three panels were loaded. In this respect it is typical of the generally observed fact that the results obtained from such tests are usually indicative of the general trend of results, but cannot be applied too rigidly as final conclusions.

This report will be published in full in an early issue of the *Institute Journal*.

THE ANNUAL BANQUET

The dinner this year was an informal affair, and was well attended. The toastmaster, Dr. Edwin Herbert Lewis, dean of Lewis Institute, Chicago, handled the program and the speakers brilliantly. Judge Clarence Norton Goodwin, Circuit Court of Cook County, the first speaker, discussed legal service and law reform. He was followed by the Rev. James Samuel Stone, who, despite his name, discussed concrete from a most interesting angle, interpreting concrete in terms of humanity. The great nations are concrete nations, of spiritual cement, and human aggregate. The concluding address was by Dr. Henry Baird Favill, a leading physician of Chicago.

STANDARDIZATION OF TESTING MATERIALS

The report of the committee on Specifications and Methods of Tests for Concrete Materials was submitted by Prof. A. N. Talbot, Univ. of Illinois, Urbana, and was an able and comprehensive analysis of tests and testing conditions. This report, in abstract, appears in other pages of this issue.

INVESTIGATION OF METAL LATH CORROSION

A most valuable report on the use of metal lath with cement stucco was prepared by J. C. Pearson, asst. physicist, Bur. of Standards, Washington. While this was a progress report, and, at some later time, when the tests are concluded, will be followed by a complete report, yet much valuable information on the behavior of metal lath in stucco is included in it.

USING LIME WITH PORTLAND CEMENT

Cloyd M. Chapman, engr. or tests, Westinghouse, Church, Kerr & Co., N. Y. C., presented interesting data on the use of cream of lime. This report will appear in a subsequent issue.

STANDARD STUCCO PRACTICE

The presentation of the standard specifications for Portland cement stucco developed considerable discussion, bringing out many points of interest. The use of hair in the first coat was considered in detail. On work which is not back-plastered, but where sheathing is used behind the lath, the specification forbids the use of hair. Without hair the mortar requires greater pressure in troweling to make it adhere, thus forcing the mortar between the meshes of the lath, and tending to enclose the lath much more thoroughly.

Hydrated lime was discussed in this connection, the question being brought up whether or not the hydrate should be made into a cream or putty before it is added to the mortar. Opinion on this question was divided.

CONCRETE FENCE POSTS

The convention closed with an interesting symposium on concrete fence post development. G. H. Dougherty³ discussed some of the problems of post manufacture. He was followed by A. M. Smith,⁴ who discussed the general problem of concrete fence posts.

Durable and Sanitary Feeding Troughs of Concrete¹

Feeding troughs for hogs can easily be made of concrete. Old lumber free from splits and knots may be used for forms. To procure an everlasting receptacle of this character simply means the

nailing together of two boards in the shape of an inverted V. These are placed on a board platform or other even surface and surrounded with a board frame or form, which is then filled with concrete. The concrete is struck off while fresh to insure an even bottom. No special finish is required and very rude work will answer the purpose. The dimensions of the trough will, of course, depend upon the length and size of the board forms. Small troughs for chickens or large troughs for hogs may be made with equal facility.

Another simple method of making a small trough is to substitute for boards half of a drain tile or terra cotta pipe for the inside form.



CROSS-SECTION SHOWING FORM, INVERTED IN MAKING THE TROUGH

Where the boards are used it would be well to oil the surface coming in contact with the concrete. This makes the removal of the forms easy. A mixture of 1 part Portland cement, 2 parts sand and 4 parts crushed stone or gravel will make a concrete suitable for this purpose.

To prevent hogs from crowding or getting into the trough, cross-pieces should be used. To provide for bolting the cross-pieces, holes should be bored in the platform at required intervals and the bolts set in with the thread end down. The bolts should go into the platform to a depth that will insure sufficient projection for the strap iron cross pieces and the nut. The concrete should be a "sloppy wet" mix and thoroughly puddled in the form. It should be kept in the form several days and protected from hot sun and wind. When sufficiently hard on the exposed surface to resist indentation with the thumb-nail, the forms may be removed. The concrete should then be sprinkled twice a day for the period of a week.

The strength of a trough of this character will increase with age. It may be cleaned easily and will resist the hardest usage. The longer it is exposed to the weather the more durable it will become.

There are approximately 16,000,000 sq. yds. of concrete pavement in the United States nearly half of this amount having been put down in 1913.

¹D. and A. Post Mold Co., Three Rivers, Mich.

²Ohio Post Mold Co., Toledo, O.

³Information through Assn. Am. Portland Cement Mfrs.

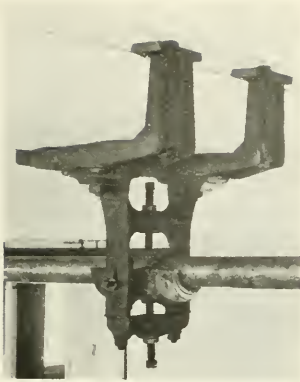


FIG. 1—DETAIL VIEW OF SLOTTED BEAMS AND GRAY IRON BRACKET CLAMPS

Supporting Shafting From Concrete Beams

Various methods have been used for the support of shafting in concrete factory buildings. Most of these have been based on the use of some form of insert, and practically all of these methods have made it necessary to determine in advance the exact location of shafting and have not provided any flexibility to allow for future shafting, changes or additions.

An interesting method for providing for this has been used by Lockwood, Greene & Co., architects, and

engrs., Boston, and is clearly shown in the accompanying illustrations. By this method a continuous groove about 1 in. deep and about 2 in. high is cast along either side of every concrete beam in the building. These grooves are located at a uniform height from the bottom of the beam and are of uniform size. The grooves

are easily formed by simply nailing a cleat inside of the forms before concrete is poured, and since the slots come, in general, below the upper half of the beam they do not detract from its strength. This method does not add appreciably to the cost of construction and the grooves are not very noticeable.

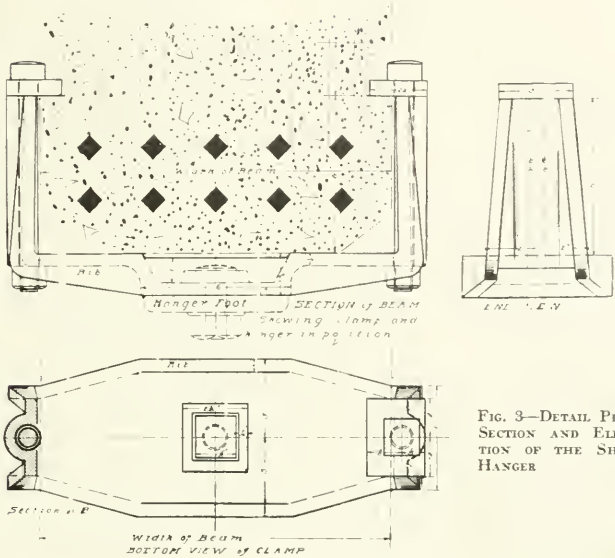


FIG. 3—DETAIL PLAN, SECTION AND ELEVATION OF THE SHAFT HANGER

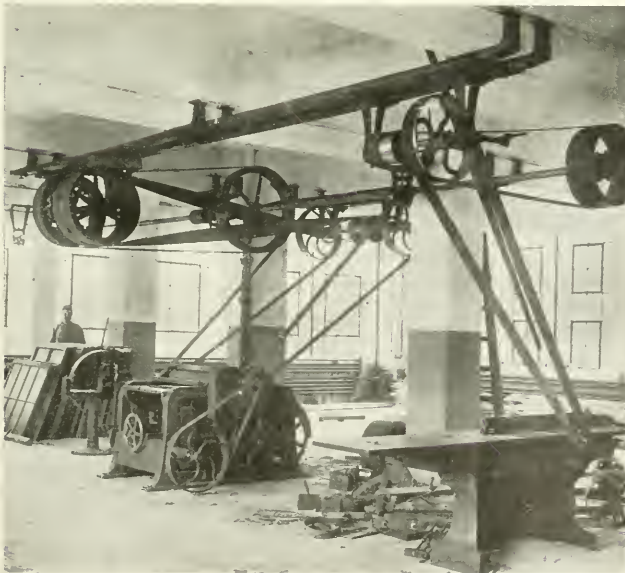


FIG. 2—AN INSTALLATION OF BRACKET CLAMPS IN A MACHINE SHOP SHOWING A SHAFT HANGER SET BETWEEN BEAMS ON CHANNEL IRONS

Clamps have been designed which fit around the inside of the beam and are held in place by bolts with plate washers at the top which fit into the grooves in the beams. The clamps are made of gray iron and it has been found that they can be cast very cheaply after the pattern has once been made. Two of these clamps are necessary for each hanger, and since the clamps are made up independently, a pair can be spaced any distance apart and thus be made to accommodate the foot of any hanger which it is desired to use. The illustrations clearly show the form of the clamp and the appearance of a line of shafting supported in this manner.

When an intermediate hanger is desired between beams, a clamp of the same style may be used to support steel channels to which the hanger is then bolted as shown in Fig. 2.

The particular advantage of this method, which is in successful use in a number of factories, lies in its flexibility in providing for changes and for future requirements.

Convention of the Tile Manufacturers. Now the American Cement Pipe Association

The convention of the Interstate Cement Tile Mfrs. Assn., which, by the way, changed its name to the American Concrete Pipe Assn., was held in Chicago in the Auditorium hotel, Feb. 17-19, inclusive. In opening the convention there was an address of welcome by J. J. Commons, of the Chicago Portland Cement Co., with a response by J. J. Hammen, Spencer, Ia., and this was followed by an address by the president of the association, P. H. Atwood, Armstrong, Iowa. Mr. Atwood dwelt upon the increase of the drain tile business and upon the increase in the amount of capital required to operate a good business, and further upon the necessity for the use of good materials and the application of good workmanship.

A. D. Miller, Goshen, Ind., discussed the business end of tile manufacture by putting emphasis upon the necessity of such a layout as will make for economical operation. In the discussion which followed, cost of manufacture in various localities was also gone into, and methods of bringing the products of the industry before the public. A paper by Arthur S. Bent, of the Arthur S. Bent Constr. Co., Los Angeles, Cal., was scheduled under the title "Construction of Concrete Pipe Lines." Mr. Bent did not attend the meeting but he sent on his paper, which was read; it dwelt more particularly upon the development of the concrete pipe business in the far West, and the boom which it has been to agriculture and horticulture through irrigation. This paper will be presented in part elsewhere in this or in a later issue.

The morning session, Feb. 18, was held jointly with the American Concrete Institute. Rudolph J. Wig, physicist of the U. S. Bur. of Standards, Washington, was scheduled for the first paper discussing "The Effect of Alkali Water on Concrete Tile," but owing to the necessity for his absence from this session, the paper had been presented the night before for the Institute. Reference to it will be found elsewhere in this issue.

George P. Diekmann, chief chemist of the Northwestern States Portland Cement Co., Mason City, Ia., presented a brief paper entitled "Some Tests on Plain and Reinforced Concrete Pipe."

This will be given in full elsewhere in this or in a later issue.

SPECIFICATIONS FOR TILE

In discussing standard specifications for drain tile, A. Marston¹ said in part:

At present there are no standard specifications for drain tile, in spite of the vast sums spent for tile drains which are constructed every year in the U. S. alone; and although the value of each of these tile drains is absolutely dependent upon the stability and durability of the drain tile of which it is made, engineers do not possess the information on which to base reasonable specifications which will secure good work without unnecessary cost. Even within the limits of a single state, as in Iowa, it has been customary up to the present time for each drainage engineer to follow his own individual notions in his specifications, and to use quite vague language concerning the qualities of the drain tile required. In carrying on the work the acceptance or rejection of the drain tile supplied by the manufacturer has depended, to a very large degree, upon the whim, or rather, notions, of the individual drainage engineer. One would reject a large percentage where another would accept practically all of the same quality of tile.

Worse than this, there has been a large amount of failure of large drain tile owing to lack of strength to support the weight of the ditch-filling material. In recent years the use of very large drain tile has increased enormously. Drainage operations are being carried out on a very large scale, and farmers object more and more strenuously to having their fields injured by the open drainage ditch. Tile drains 36" in diameter are now common, and those of 48" are not unknown. It is with tile 20" in diameter and upwards that most of the trouble from cracking has occurred. Until now engineers have had no definite scientific data upon which to base standard specifications which would prevent this cracking, without unreasonable cost which would prevent the use of the drain tile instead of the open ditch.

Under these circumstances the Am. Soc. for Test. Mat., which is the recognized authority in the U. S. for the preparation of standard specifications for all kinds of materials of construction, has appointed a committee designated as C-6, to undertake the preparation of standard specifications for drain tile. This committee has been in existence three years. It has been fortunate in enlisting the services of a number of experimental laboratories of high reputation and in securing the co-operation of widely known manufacturers and engineers. It has just completed a series of 600 strength tests made especially for its use, and has under way an extensive series of absorption tests, likewise made especially for its use. It is now hoped that in the im-

mediate future the committee can formulate fair, reasonable and safe standard specifications for drain tile. The committee has found the problem of preparing specifications for drain tile to be complicated and delicate.

First: Drain tile of quality used extensively, and with satisfaction in many cases, are made of many different materials. In the case of clay drain tile, one class of manufacturers has used surface clays, producing a very porous tile wall which, nevertheless, has proven durable in thousands of miles of farm drains, especially in the smaller sizes; another class of manufacturers has used impure fire-clays, making very strong tile, but with porosity somewhat higher than in the case of shale tile; a third class of manufacturers has used shale, which, when thoroughly vitrified, makes in general a tile not only strong but with a very low degree of porosity. All of these clay tile have proven satisfactory in extensive use and have been made in almost all imaginable proportions, varieties of cement, kinds of aggregate and processes of manufacture and curing.

Second: The methods of laying drain tile in the actual construction of tile drains vary greatly. Most commonly they are laid in such a manner that the bottom bearing extends over only a portion of the lower one-half of the external surface of the tile; and also in such a manner that the tile receive little or no side support from firmly packed earth. In some cases, however, drain tile have been laid as carefully as is required in standard specifications for sewer pipe construction, which generally require very careful bedding of the pipe and tamping of the earth at the side. In a few cases drain tile have been laid, under unusual conditions, in cradles of concrete.

Fair and reasonable standard specifications for drain tile will take into account all these different materials and methods of laying.

REQUIREMENTS

The requirements which should certainly be incorporated in standard specifications for drain tile may be grouped under three heads. 1. General Requirements; 2. Absorption Requirements; 3. Strength Requirements. It is possible that other requirements may need to be added, such as special tests of durability, freezing and thawing and resistance to acids and alkalis. General requirements will include such specifications as are now very commonly made to the effect that the tile shall be good, sound tile; free from cracks and checks; with uniform, strong, dense structures; giving a clear ring; regular and true in shape. The percentage of absorption of drain tile is not in itself a cardinal quality of the tile. It is now agreed by all competent drainage engineers that the proper place for the water to enter the tile is through the joints, and not through the pores of the tile walls. The absorption is specified as an indirect method of specifying the quality of the material in the tile walls. The strength of drain tile to carry the loads imposed by ditch filling, on the other hand, is a cardinal quality of the material. Unless the tile have a safe strength they are liable to be cracked in the ditch by the weight of the ditch filling. Since the weight of the ditch filling resting upon the tile is independent of the material of which the tile are made, the same strength should be specified for one kind of clay tile as another and the same strength for concrete tile as for clay tile. The really difficult

¹Dean, Div. of Engrg., Ia. State Coll., Ames

question to decide in connection with strength requirements for standard specifications for drain tile is what actual loads the tile are reasonably certain to be liable to have to carry for different depths and widths of ditches and varieties of soil; and the safety factor of strength which would be specified to provide for variations in the strength of the tile and in their loadings from ditch filling.

There has been a sufficiently great number of cases in the construction of large drain tile in which cracking has resulted from insufficient strength to carry the weight of the ditch filling to make it advisable to adopt standard specifications requirements for bearing strength which shall certainly prevent such cracking. However, to construct drain tile with the increased strength necessary to insure safety in deep and wide ditches will call for material increase in their cost. The average tile drain is not of uniform depth throughout its length. Comparatively limited portions are usually much deeper than the greater part of the drain. In some cases it would add greatly to the cost of the drain to require pipe throughout its length capable of carrying safely the loads in the limited deep stretches.

Committee C-6 is earnestly endeavoring to overcome the various difficulties which have been enumerated. Among the possibilities for a solution may be mentioned the following:

1. The adoption of standard loads for different depths and widths of ditches and varieties of soil which it is reasonably certain that drain tile are liable to have to carry.

2. The determination of a factor of safety which experience with sound pipe in actual ditches has shown to provide reasonable safety against cracking.

3. The division of drain tile into classes A, B, C, D, etc., as has already been done with water pipe, and the specifying of the minimum bearing strength per lin. ft. for each class.

4. The specification of limits of depth and width of ditches for each main variety of soil where drain tile of each class may be used without special precaution in laying.

5. The specification of an additional allowance, possibly stated as a percentage, which shall be granted for care in laying equal to that given in the best sewer construction practice.

6. A specification permitting the use of drain tile in depths and widths of ditches exceeding the limits specified under No. 4 above on condition that the pipe be strengthened by laying in a cradle of concrete.

LAYOUT OF PRODUCTS PLANTS

"The Layout of Products Plants," was the title of a paper by E. S. Hanson, editor of *Cement Era*, which brought under discussion plants which are laid out ideally for handling their operations, showing drawings by means of stereopticon, and which also brought out the defects in certain other layouts. In the discussion which followed, A. E. Cline, formerly at Winnipeg, Man., now at Peekskill, N. Y., discussed something of the layout and methods of handling material at the Winnipeg plant, where he was in charge

until a year or so ago. This plant was described in *CONCRETE-CEMENT AGE*, July, 1912, p. 35. Mr. Cline mentioned particularly that in connection with the use of the mixer there were bins around the room containing the various aggregates used, and instead of an automatic conveying apparatus to bring these aggregates to the mixer, carts were used with a capacity of 7 cu. ft., and the workmen brought the materials for a mix with the necessary amount of cement piled on top, from the bins to the mixer, dumping the material in at the top direct from the working floor. Mr. Cline called attention to the fact that by this arrangement the concrete mixture was always under control, and could be varied at any time as necessity might require.

STEAM ROOM DOORS

Another speaker brought up the subject of doors for steam rooms, a problem which has been under discussion in the Information-Consultation Department of this magazine. The speaker recommended the use of galvanized sheet iron of about 30-ga. instead of canvas, the metal fastened on a wooden frame in much the same way as canvas is used. The speaker said he had tried canvas in much the same way and the limit of life was 18 mos., while the galvanized iron had been in use for more than a year and showed no signs whatever that it would not be good for a long time to come. A further testimonial to the galvanized sheet iron for this purpose came from still another speaker who said he had had it in use for eight years without renewing.

There was also a discussion of the use of prepared roofing material to be fastened on a frame, for steam room doors, one speaker having had it in use for two years with excellent results, the material having the advantage of being very light in weight and very cheap. Still another speaker who had tried the roofing material for steam room doors said he had found it not satisfactory, that in time it became brittle and was punched full of holes.

The annual dinner of the tile men was held in the Auditorium Wednesday evening, with Ernest McCullough as toastmaster.

The tile men convened again Thursday afternoon, when there was presented an excellent paper on concrete sewer pipe manufacture and use, by W. B. Dunning, asst. engr., Universal Portland Cement Co. About an hour's time was devoted to discussions of various tile machines, with practically all of which, however, readers of *CONCRETE-CEMENT*

AGE are familiar. At the business session which followed, the name of the organization was changed, as already noted, because the new name seems to cover more fully the scope of the work which it is intended the Association shall undertake. P. H. Atwood had requested that he be relieved of the duties of the presidency, and B. Blair, Woodstock, Ont., was chosen to succeed him. J. J. Hammen, Spencer, Ia., was elected vice-pres., and E. S. Hanson, Chicago, was re-elected sec.-treas.

One Way of Handling Labor Troubles

The efficient and economical conduct of construction work requires tact of the greatest kind. When the Aberthaw Construction Co. was doing its first work in Buffalo several years ago, it was for a firm which had had considerable trouble with labor and it was anticipated that there would be a strike before the job was very far advanced. This Buffalo firm had been marked by the local labor organizations as their natural prey, and the labor organizations were also prejudiced against outside firms coming into their territory. The carpenters in Buffalo had a strong organization.

In the early stages of this job, while there were but a few carpenters, the superintendent could give them considerable personal attention and things went smoothly, but as soon as work began on the second floor where they could not be so easily seen and the superintendent was too busy with other matters to watch them closely, unit costs began to climb, day by day.

The superintendent studied the situation to find the cause. By the time form work was starting on the third story he became convinced that the union steward on the job was to blame and was holding the men back from doing their best. The natural impulse would have been to discharge him immediately, but that would have made hard feeling with the union. The superintendent took this man aside, confided to him his troubles, and then made this man sub-foreman with entire charge of erecting forms for columns, which was the particular item which showed the highest cost. Immediately the costs came down, and on the fourth story were the lowest on the whole job. The result was saving a thoroughly first-class workman and keeping in the good graces of the local organization. Some years have gone by since, and there has been no trouble whatsoever with the labor situation in Buffalo.

Effect of Hydrated Lime on Change in Volume and Strength of Mortars and Concretes¹

By HENRY S. SPACKMAN²

Discussion of the suggested use of hydrated lime in concrete road construction at last year's meeting of this Association, developed the fact that though the effect of the addition of from 10% to 15% of hydrated lime on the permeability, plasticity and strength of Portland cement mortars and concretes had been more or less thoroughly studied by numerous investigators, no data were available as to the effect of such additions on the change in volume of concrete mortar. In consequence, the laboratories with which the writer is connected were, through the joint action of several of your members, commissioned to investigate the subject. The purpose of this paper which was prepared at the request of these gentlemen is to place before you the results obtained to date. The investigation, however, is far from complete, few of the tests having gone beyond the six months period.

As the work of previous investigators, together with extended use in construction, had demonstrated that the plasticity and impermeability of Portland cement mortars and concretes were increased by the addition of hydrated lime without marked reduction in strength, no specific tests were made for plasticity or impermeability, the work being confined chiefly to the study of the effect of different conditions of exposure with and without addition of hydrated lime on the change in volume of Portland cement mortar and concrete test pieces. As a check, however, on the effect of different conditions of exposure on the strength, full sets of briquettes for year test were made from each mixture, and some 6-in. cubes. Full sets of 2-in. mortar cubes were made—but either because our compression machine was too large for such small test pieces or some other reason—the results obtained were so erratic and showed such variation from each other and from results obtained by other investigators, that we think they should be disregarded.

In view of the fact that the standard methods of testing cement were

developed for the purpose of determining the quality of the cement, and throw little or no light on the strength which mortars and concretes made from the same cement will develop under the varied conditions found in actual construction, it was decided in this investigation to depart from the standard practice both in the quantity of water used in gauging the mortar and the exposure of the test pieces under observation. It was also considered advisable to use commercial material for the finer aggregate, instead of standard sand.

The cement used was a typical Portland cement made by intimately blending by mechanical means equal parts of four well known brands of Portland cement, each of which by previous test had been shown to be normal. The mixture was also tested and met all the requirements of the standard specifications.

Two types of hydrated lime were used, one being a high calcium hydrate and the other a magnesian hydrate. These were prepared in the same manner as the cement, by intimately mixing several well known brands of each class. These mixtures met the requirements of the proposed specifications for building hydrate presented by Committee C-7 on Standard Specifications for Lime, of the Am. Soc. for Test. Mat., at the meeting of that Society in June, 1913.

The finer aggregate used was a washed Jersey gravel of better quality than is ordinarily furnished for construction work in Philadelphia and vicinity, the mechanical analysis being as follows:

Sieve	% Passing
No. 1	100.00
No. 10	91.50
No. 20	81.50
No. 30	71.70
No. 40	61.10
No. 60	44.00
No. 100	24.45
No. 200	9.00
No. 300	2.40

CONTRACTION AND EXPANSION OF MORTARS

As previous work had shown that the expansion and contraction of cement were more or less masked by the addition of aggregate, neat cements showing greater movement than when mixed with sand and sand mortars supposedly having a greater movement than concretes, it was decided to omit the coarse aggregate

in making up the laboratory test pieces.

Scope of Tests—The proposed investigation being primarily to study the effect of the addition of varying amounts of hydrated lime on the expansion and contraction of mortars and concretes, and secondarily, the effect of the variations of exposure on the strength, it was decided to confine the work to five typical mixtures, as follows:

No. 1—1 part cement, 3 parts gravel.

No. 2—9/10 part cement, 1/10 part high calcium hydrate, 3 parts gravel.

No. 3—9/10 part cement, 1/10 part magnesian hydrate, 3 parts gravel.

No. 4—8/10 part cement, 2/10 part high calcium hydrate, 4 parts gravel.

No. 5—8/10 part cement, 2/10 part magnesian hydrate, 4 parts gravel.

Under Water—Test specimens were stored under water in tanks in the laboratory.

THE TEST PIECES

In Air—Test specimens were stored in the dry air of one of the rooms of the laboratory.

Out of Doors—Test specimens were laid on the ground exposed to the action of the elements for the first five mos.; then placed on trestles in order to prevent the taking of measurements being hampered by snow and ice.

Alternate—The test specimens were stored alternately under water and in air. For the first portion of the test the specimens were placed two weeks in air and two weeks in water. Later the duration of the several exposures was changed.

A sufficient amount of each mixture to cast all the test pieces was mixed and gauged at one operation. The cementing material and gravel were thoroughly mixed dry by hand; then water was added to the batch, which was turned six times, enough water being added to render the mortar sufficiently plastic to be poured or applied with the trowel.

Size of Specimens—All test pieces were 3' 3" long by 4" square.

Molding—Molds were close-fitting white pine boxes, fastened together with screws. Copper points were cast in the ends of the specimens, being located approximately in the center. The molds were placed horizontally during filling, and were not disturbed during the first 48 hrs., at which time the sides and ends were removed. The test specimens remained in the original position for

¹Presented at meeting of National Lime Mfrs. Assn., N. Y. C., Feb. 4-5, 1914

²Henry S. Spackman Eng'g. Co., Philadelphia

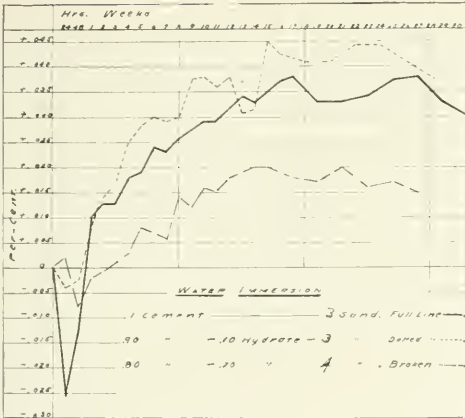


FIG. 1

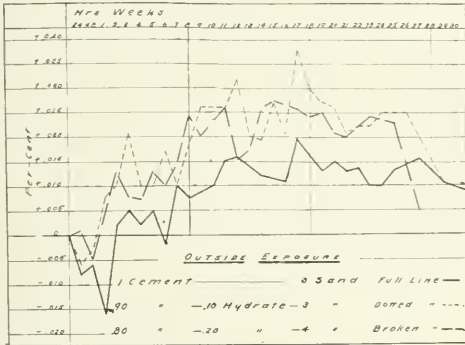


FIG. 3

48 hrs. longer, when they were divided at random into four lots, the first lot being stored under water, the second lot in air, the third lot out of doors; the fourth lot was placed in tanks and exposed alternately under water and in air.

Readings—The first reading, made four hrs. after casting, was considered the original length of the test pieces. All measurements in excess of this are considered plus; all measurements less than this minus.

Micrometer—The micrometers used in taking the readings were especially made, and consisted of a hollow drawn steel tube, to each end of which there was permanently attached an aluminum arm extending some 6". In one of these arms there was fixed a reading point, and in the other a micrometer screw reading to 1/100 mm. The micrometer was not self-compensating for changes in temperature.

As the purpose of the investigation was to determine the effect of the addition of hydrated lime on the

content, and there was no reason to suppose that the addition of hydrate would affect the coefficient for change in temperature, it was assumed, for all practical intents and purposes, that by using a steel micrometer bar having practically the same coefficient of expansion under temperature changes as concrete the readings would give the change in volume due to the change in moisture content, care being taken at all times to bring the micrometer to as closely as possible the temperature of the specimens being measured.

Result of Tests—The curves of Figs. 1, 2, 3 and 4 are plotted from actual readings, no correction being made for the effect of variations of temperature on the micrometer. All positions of curve above the heavy horizontal line are plus and indicate expansion, all positions below the heavy line are minus and indicate contraction. The measurements from which the curves are plotted are the average of two or three specimens from each exposure for cement mor-

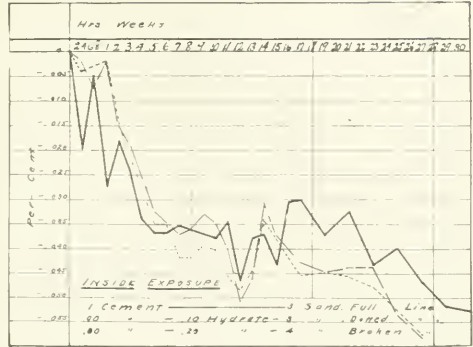


FIG. 2

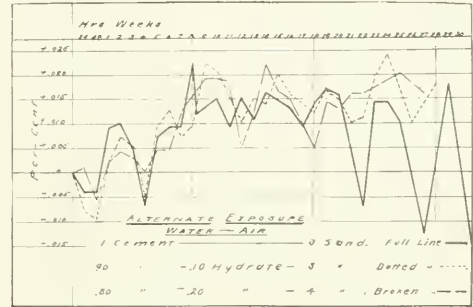


FIG. 4

tars, and from four to six specimens for those mixtures containing hydrated lime. The curves of the mixtures containing similar amounts of high calcium and magnesian hydration lime were combined in order to avoid crowding and overlapping of the two closely similar curves. The ordinates are periods of time; the abscissae, thousandths of a per cent.

Tests on Concrete—As a check of the results obtained from the smaller test pieces, from which broken stone was omitted, six concrete test pieces, 6' 6" long, 18" wide and 6" thick were cast. These rest directly on clay soil out of doors, exposed to the full influence of the weather, with provision for drainage, the natural surface of the ground (which was level) having been excavated to a depth of 6", so as to bring the top of the test pieces flush with the surrounding ground. Each test piece was separated from the adjoining one by layers of tar paper, held in place during casting by thin boards. These boards were not sufficiently stiff to resist the sideways pressure of the concrete, and the dividing lines between the several specimens are, in consequence of the bending of these boards, irregular, and each piece is not, owing to friction with the ad-

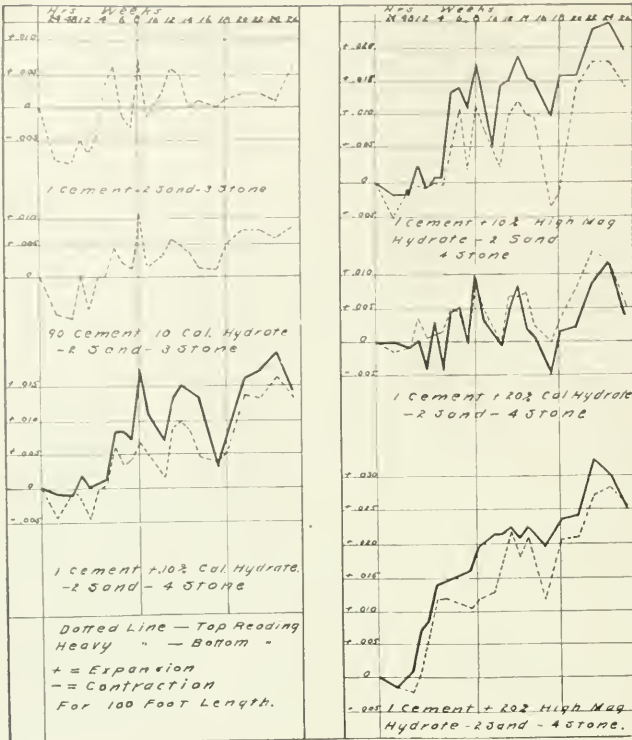


Fig. 5

joining pieces, entirely free to expand or contract independently of the others. The curves of Fig. 5 are plotted from actual measurement, no correction being made for the effect of variations of temperature on the micrometer readings. All measurements below the heavy line are minus and indicate contraction. All measurements above the heavy line are plus and indicate expansion. The proportions of cement, gravel and stone in these mixtures are by volume, one bag of cement (94 lbs.) being considered as 1 cu. ft. The addition of hydrated lime was by weight. Where two lines appear, the dotted line represents measurements taken on points located 2" from the top of the specimen; the solid line represents measurements taken on points located 2" from the bottom of the specimen.

It should be borne in mind in the consideration of these curves, that while all the test pieces representing any particular mixture were cast at the same time and consequently at any given period were exposed to identical weather conditions, the opposite is true of the various compositions, some four or five days elaps-

ing between the casting of each two lots of test pieces.

INDICATIONS OF THE TESTS

It is unwise to draw general conclusions from a single series of tests, especially where both tests and methods are new, and some of the test pieces show marked variation from the average results obtained. But where certain marked characteristics are found to persist throughout an entire series of tests and show up markedly in the average as well, it is reasonable to assume, until the contrary is shown, that these characteristics are typical of the material under examination and will show themselves in actual construction. If we are correct in this, the curves in Fig. 5 and the curves of the individual test pieces, some 60 in number, from which the curves showing the average were compiled, indicate the following:

That variation in moisture content more than change in temperature affects the volume of the test piece.

That when kept from contact with water other than the moisture in the air, there is a marked tendency to shrinkage of the test piece, which

tendency continues up to and beyond the 6-mo. period.

That where the test piece is in constant or frequent contact with water, the general tendency is towards expansion in volume.

That with the draining off of the excess gauging water, there is a marked shrinkage at the 24-hr. period, followed in some cases by expansion at 48 hrs. and further shrinkage if test specimens are out of contact with water and expansion if in contact with water.

That the addition of hydrated lime, while increasing somewhat the maximum expansion and contraction when the test specimens are constantly exposed either to water or dry air, markedly reduces the shrinkage due to the draining off of the surplus gauging water and also the extent of the movement when the test piece is ultimately wet and dried. The curve of alternate exposure to water and air shows that where cement alone was used as a binding material the test pieces were in tension four times, whereas the test piece containing hydrate shows much less movement.

While the purpose of the test was chiefly to study the effect of the addition of hydrated lime on the expansion and contraction of cement mortars and concretes, it was thought advisable, in view of our departure from normal methods of testing in the amount of gauging water and condition of exposure, to run a series of physical tests to determine the effect on the strength of using a wetter mix, and of the addition of hydrated lime under the several conditions of exposure.

TENSILE TESTS

The materials used were identical with those used in making the expansion test pieces, except the gravel was all passed through a 1/4-in. mesh sieve to remove the larger pieces. Four sets of test pieces for both tension and compression were made from mixtures corresponding to each of those used in the tests for expansion and contraction. These were exposed in the same manner as the expansion test pieces, except those stored out of doors, this exposure being more severe, as the specimens were placed on a tin roof exposed to the direct rays of the sun, full force of storms and all variations in temperature.

The comparative results obtained under tension for the different conditions of exposure are shown by the curves in Figs. 6, 7, 8 and 9. The curves showing results obtained from mortars containing various additions of lime are plotted from the average

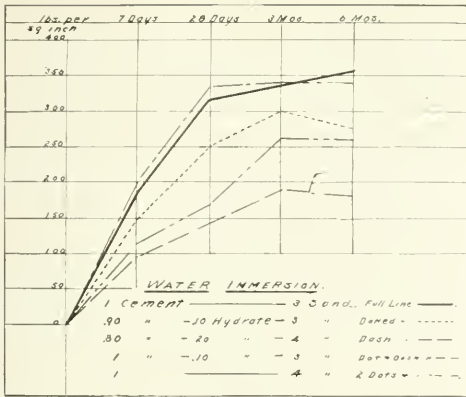


Fig. 6

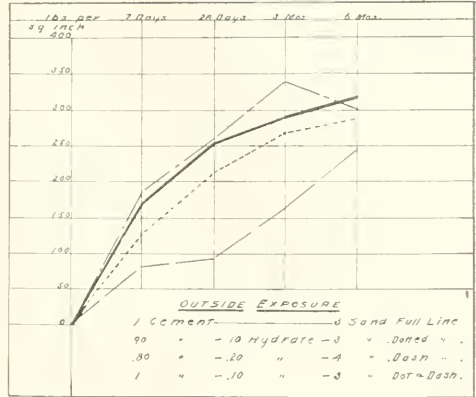


Fig. 7

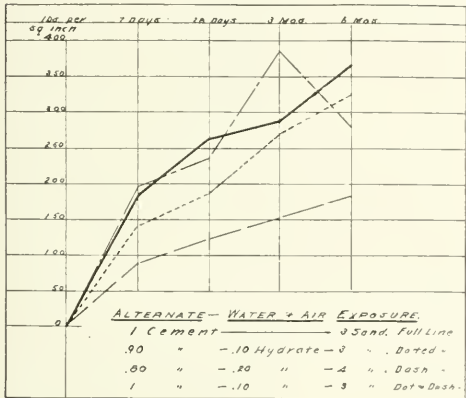


Fig. 8

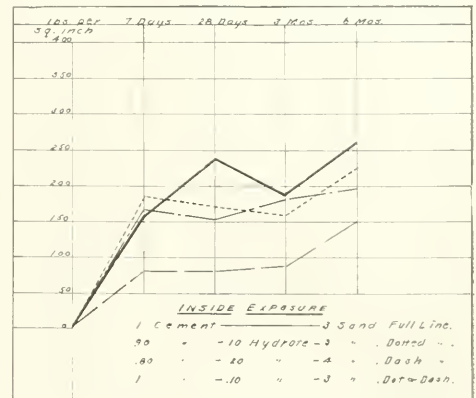


Fig. 9

of two sets of specimens, one made from high calcium hydrate and the other from magnesian hydrate.

In these tests the mortars were all made of work consistency, i. e., sufficiently wet to be applied by the trowel or poured, which required about 50% more gauging water than would have been required for standard laboratory consistency. See Figs. 6, 7, 8 and 9.

COMPRESSION TESTS

The materials and mixtures used in these tests were the same as those used in the tensile tests.

The mortars were all made of work consistency, i. e., sufficiently wet to be applied by the trowel or poured, which required about 50% more gauging water than would have been required for standard laboratory consistency. The results given are in lbs. per sq. in., and are the average of three test pieces.

As previously stated, the results obtained from the crushing of the

2-in. cubes was exceedingly erratic, there being in some cases a difference between the individual test pieces of almost 100%.

The surplus material from casting the expansion bars was made into 6-in. cubes. These, when broken at the 3 mos. period, showed the strengths as given in Table V.

A full set of 6-in. cubes, with the exception of the 1 cement, 2 sand, 3 stone mix, were made from the various mixtures used in casting the expansion and contraction test pieces, 6' 6" in length. These cubes were stored out of doors, subject to identically the same exposure as the concrete expansion test pieces. The results obtained from the crushing of these cubes up to the 6 mos. period is shown in Table VI.

We are at a loss to explain why the 2-in. cubes containing hydrated lime show generally less strength than the 2-in. cubes made from cement, without addition of hydrated lime, when the 6-in. mortar cubes

show a marked increase in strength where 10% of hydrated lime was added, and practically the same strength where 10% of hydrated lime was substituted for the cement. In the same way, the 6-in. cubes made from the concrete mixtures, while not directly comparative—as the mixtures in which lime was added carry more stone—show no marked reduction in strength from the addition of lime; these contradictions, together with the great variance between the strength of individual test pieces of identical composition and exposure, broken at the same periods, as well as the results of other investigators (which generally show an increase in strength under compression where hydrate is used), lead us to believe that the low average strength obtained on the 2-in. mortar cubes is due to some defect in our method, and is not truly representative of the strength developed under compression where hydrated lime cement mortars.

TABLE I

Comparative tests showing resistance to compression of 2-in. cubes made from Portland cement mortars, with and without the addition of hydrated lime.

Test pieces stored <i>under water</i> . (Results in lbs. per sq. in.)				
	7 das.	28 das.	3 mos.	6 mos.
1 cement, 3 sand...	1,132	3,207	3,350	3,591
1 cement+10 hydrat- ed lime, 3 sand...	1,368	1,897	2,713	3,110
.90 cement, 10 hydrat- ed lime, 3 sand...	1,187	1,686	2,541	3,308
.80 cement, 20 hydrat- ed lime, 4 sand...	670	909	1,190	1,101

TABLE II

Comparative tests showing resistance to compression of 2-in. cubes made from Portland cement mortars, with and without the addition of hydrated lime.

Test pieces stored <i>in air outdoors</i> . (Results in lbs. per sq. in.)				
	7 das.	28 das.	3 mos.	6 mos.
1 cement, 3 sand...	916	1,860	1,302	1,820
1 cement+10 hydrat- ed lime, 3 sand...	817	1,288	1,606	1,661
.90 cement, 10 hydrat- ed lime, 3 sand...	938	917	1,371	1,386
.80 cement, 20 hydrat- ed lime, 4 sand...	317	580	570	612

TABLE III

Comparative tests showing resistance to compression of 2-in. cubes made from Portland cement mortars, with and without the addition of hydrated lime.

Test pieces stored <i>out of doors</i> . (Results in lbs. per sq. in.)				
	7 das.	28 das.	3 mos.	6 mos.
1 cement, 3 sand...	1,068	2,091	2,227	2,898
1 cement+10 hydrat- ed lime, 3 sand...	1,077	1,010	1,516	2,060
.90 cement, 10 hydrat- ed lime, 3 sand...	751	1,091	1,430	2,061
.80 cement, 20 hydrat- ed lime, 4 sand...	465	631	1,025	1,109

TABLE IV

Comparative tests showing resistance to compression of 2-in. tubes made from Portland cement mortars, with and without the addition of hydrated lime.

Test pieces stored <i>alternately 2 wks. in water and 2 wks. in air</i> . (Results in lbs. per sq. in.)				
	7 das.	28 das.	3 mos.	6 mos.
1 cement, 3 sand...	1,155	2,705	3,245	3,111
1 cement+10 hydrat- ed lime, 3 sand...	1,118	2,112	2,713	3,720
.90 cement, 10 hydrat- ed lime, 3 sand...	1,181	1,590	2,399	2,685
.80 cement, 20 hydrat- ed lime, 4 sand...	666	772	1,400	1,381

These tests for strength indicate that Portland cement mortars and concretes, either with or without the addition of hydrated lime, develop the greatest strength when in continuous contact with water; that where allowed to harden in air out of contact with water there is a marked diminution of strength; that,

considered broadly, the addition or substitution of 10% of hydrated lime has no marked effect on the strength of the mortars, the tests showing increase in strength at some periods and decrease in strength at others.

In conclusion, the investigation as a whole, in our opinion, indicates that the addition of hydrated lime will be found advantageous under ordinary climatic conditions, not only in concrete road construction, but in concrete work generally, where it is exposed either in air or to fresh water, as concrete to which such additions have been made, besides being more impermeable, will show less change in volume under varying moisture content.

Educating the Cement User by Showing Mills

One way to make customers for concrete roads, and a very excellent one, has been tried by one of the large cement companies in the Lehigh region, and that is to take the road builders themselves to visit the cement mills in order that they may become familiar with the care and skill with which Portland cement is manufactured. No engineer who has ever visited a first-class cement mill ever leaves it without the impression that the manufacture of Portland cement is a serious and difficult business, and that the product is one entitled to the fullest confidence of any profession relying upon science and accuracy for its work.

A whole trainload of road supervisors and road engineers was recently taken up to one of the large works in the Lehigh region and spent a day in learning all about the manufacture of cement. Such visits as these produce good results, and familiarity with the manufacture of cement never breeds contempt, but on the contrary imparts respect and regard for the material and leads to its larger use.

Standard Sizes Make For Economical Centering

Because concrete is a plastic material cast in place and because the molds can be made of any design, engineers seem to feel that there is no necessity for holding to any standard sizes for the members of a concrete structure, as they do when designing in steel. An engineer can, however, use quite an amount of thought to good advantage in the selection of sizes, as the particular dimensions which best satisfy his designs will quite often not be the most economical. In commenting on this, L. C. Wason states that in one building of large size there were in the original design received 155 different sizes and styles of beams in a single floor. The contractor's designing department found it possible, without impairing the result to be accomplished, to reduce these to less than a sixth of the original number, and by co-operation with the engineers finally succeeded in reducing the number to 52. For maximum economy wooden forms should be made from plans drawn to scale, at a bench on the site, and assembled in place without the use of any tool but a hammer. This requires almost as great precision as does the use of structural steel.

"Lawing" for "Pure" Construction

Blessed be the Legislator—for he is having all the fun. It matters not what occurs, he is "in the ring" with his little law to improve the situation. The recent concrete failure at Cedar Rapids, Ia., is the last producer of new laws, and now the legislator is at it again with his little remedy for concrete failures. The demand now is that there shall be a "pure" concrete or "pure" cement law. It is needless to say, "inspectors at salaries" and again "assistants at salaries" are to enforce this new law. Verily the tax-eater is to be in his element, as there is no limit to the number of "sub-assistants" these assistants may in turn appoint.

While CONCRETE-CEMENT AGE stands for good concrete and safe concrete construction, it does not believe in needless laws to regulate that which proper inspection and proper specifications already can and do provide for. Owner, engineer and contractor should co-operate for permanent and honest construction, but where owner or contractor desires to "skimp" the work for purposes of economy, failures are likely to result and a whole book of laws on the subject would not profit us anything.

TABLE V

(Results in lbs. per sq. in.)				
	1 cement 3 sand	1 cement + 10 hydrate 3 sand	.90 cement + 10 hydrate 3 sand	.80 cement + 20 hydrate 4 sand
Stored under water.....	1,793	2,719	1,769	853
Stored out of doors, exposed to the weather	1,700	2,405	1,718	738

TABLE VI

(Results in lbs. per sq. in.)				
	7 das.	28 das.	3 mos.	6 mos.
1 cement, 2 sand, 3 stone.....	1,484	1,905	2,913	not made
.90 cement, 10 high calcium lime, 2 sand, 3 stone.....	1,310	1,516	2,412	3,133
1 cement + 10 high calcium lime, 2 sand, 4 stone.....	1,718	1,803	2,101	2,931
1 cement + 10 high magnesium lime, 2 sand, 4 stone.....	1,646	1,756	2,340	2,784
1 cement + 20 high calcium lime, 2 sand, 4 stone.....	1,323	1,635	1,745	2,153
1 cement + 20 high magnesium lime, 2 sand, 4 stone.....	1,320	1,638	2,008	2,123

The Work Done by the First National Conference on Concrete Road Building

The National Conference on Concrete Roads held at Chicago, Feb. 12-14 inclusive, resulted in a big and important stride in the direction of standardization of best practice in concrete road construction, receiving 14 reports from as many different committees on various phases of the work. The only committee of the entire 15 named, not presenting a report, was the committee on Reinforcement, which did not complete its deliberations in time for presentation to the Conference. While four other reports presented are not in finished condition and available for publication at this time and while the 10 finished reports are subject to later revision, nevertheless the work of the Conference was remarkably well done, because through its special committee on Resolutions it was able to formulate a Recommended Practice.

W. F. M. Goss, Dean of the College of Engineering, Univ. of Illinois, Urbana, chairman of the Advisory Committee as originally appointed, was made permanent chairman; J. P. Beck, Universal Portland Cement Co., to whom much credit is due for the work of organization, was made permanent secretary and Ira O. Baker and A. N. Johnson were made vice-chairmen.

Practically all of the work of the Conference was special committee work and their reports, together with some of the discussion, will be presented in order. Aside from committee work, there were special addresses as follows:

An introductory address was made by Chairman Goss on "The National Conference on Concrete Road Building," explaining the purposes of the meetings for consideration of elements of best practice in concrete road work.

"Financing Permanent Roads" was the title of an address by S. E. Bradt, secy. Illinois State Highway Commission.

"Can a Rural Community Afford Permanent Roads?" was answered first in the negative by Oliver H. Dunlap, president Iowa State Supervisors' Assn., Kalona, Ia., and then

he considered the affirmative side which has to look a long way ahead and at the results and not at the initial expenditure.

Edward N. Hines, chairman Bd. of Co. Road Commrs. for Wayne Co., Mich., was introduced as the "Father of Concrete Roads" and gave a talk on Wayne Co. methods illustrated by motion pictures.

"Experiments with Concrete for Roads Conducted by the U. S. Office of Public Roads" was the title of a paper by J. T. Voshell, Senior Highway Engr., U. S. office of Public

Roads, Washington. This paper will be published elsewhere in this or in a subsequent issue.

"A Paper on Concrete Road Construction by the Ohio State Highway Department," by H. D. Bruning, State Div. Engr., Columbus, will also be presented in full.

In the account of the work of the Conference the last thing is taken up first—the Recommended Practice presented by the Resolutions Committee. The committee reports on which this is in considerable measure based are presented in order.

National Conference Recommended Practice for Concrete Road Construction

Brief Summary of Fundamental Principles—The salient features of the Recommended Practice adopted by the Conference are:

1. The aggregates should be clean and hard.
2. The sand should be coarse and well graded.
3. A rich mixture should be used.
4. The materials should be correctly proportioned.
5. The materials should be thoroughly mixed.
6. The inspection should be intelligent and thorough.
7. When in doubt, reinforce the pavement.
8. The sub-grade should be of uniform density, thoroughly compacted and drenched with water immediately before placing concrete.
9. The concrete should be of a viscous, plastic consistency.
10. After placing, the concrete should be immediately covered and kept moist and not opened to traffic for four weeks.

The following practice is recommended, based on the reports submitted and the discussions thereon:

I. GRADING

(a) *Slopes and Grades*—The grade of the roadway and the side slopes should be determined by an engineer to meet the local conditions.

(b) *Excavation or Treatment of Existing Roadway*—The fundamental requirement of the sub-grade is that it should at all times be of uniform density, so that it will not settle unevenly and cause cracks in the surface of the pavement, and no part of the work is more worthy of intelligent care and painstaking labor than the preparation of the sub-grade; the slight additional cost necessary to insure good results is abundantly justifiable. When the pavement is constructed on virgin soil, care should be taken to remove all soft spots so as to insure a uniform density; and if constructed on an old roadbed, even greater care must be taken in preparing the sub-grade, which is likely to be more compact in the center than at the sides, and consequently there is more danger that the pavement will settle unevenly, causing cracks.

(c) *Fills*—Where roadways are constructed over fills, extreme care should be observed to insure the use and deposit of proper material in layers of such thickness that they may be thoroughly compacted so that when the fill is completed there will be a minimum of settlement. The fill should be allowed to stand for as long a time as possible so that it will have an opportunity to settle thoroughly before the pavement is placed thereon. In general, the material composing a fill should be deposited in layers not more than one foot in thickness and each layer should be thoroughly wetted and compacted with a roller weighing not less than 10 tons.

(d) *Sub-grade*—Before the pavement is laid, care should be taken to bring the sub-grade to proper elevation and to see that it is thoroughly compacted; any soft spots or settlements should be filled with a suitable material.

2. DRAINAGE

The drainage of the roadbed of a pavement is of vital importance. If the sub-grade is not well drained, there is danger of unequal settlement after the pavement is laid, causing longitudinal cracks; there is also a possibility that the frost may lift the edges of the pavement and likewise produce cracks. The character of drainage necessary will depend on local conditions. It is recommended that, in general, proper drainage may be secured through lateral ditches. If underground water is present this may be drained through the use of drain tile laid at a suitable depth on either side of the roadway, or on one side with cross-drains from the other side. The top of the tile should not be less than 3' below the sub-grade.

3. MATERIALS

(a) *Portland Cement*—The Portland cement should meet the requirements of the Standard Specifications of the American Society for Testing Materials.

(b) *Aggregates*—The Conference is of the opinion that naturally mixed aggregates should not be used without screening and remixing in proper proportions. The quality of the aggregates can usually be materially improved by washing. Aggregates should not contain frost or frozen lumps.

(A) *Fine Aggregate*—Fine aggregate should consist of sand, crushed stone or gravel screenings, graded from fine to coarse and passing when dry a screen of one-quarter inch mesh. It should be preferably of silicious material, hard and durable, clean, free from dust, loam, vegetable or other deleterious matter.

In first-class sands, properly graded from fine to coarse, not more than 15% of the grains will pass a sieve having 50 meshes to the linear inch and not more than 2% will pass a sieve having 100 meshes to the linear inch. Fine aggregate should be of such quality that mortar composed of 1 part Portland cement and 3 parts fine aggregate, by weight, when made into briquettes, will show a tensile strength at least equal to the strength of a 1:3 mortar of normal consistency made with the same cement and standard Ottawa sand.

Since it is impossible to determine the quality of sand by the usual eye and hand examination, the Conference is of the opinion that their quality should be determined by tests for tensile strength and mechanical analysis.

(B) *Coarse Aggregate*—Coarse aggregate should consist of clean, hard and durable gravel or crushed stone graded in size, all of which will pass an inch and a half and be retained on a one-quarter inch screen. It should be clean, hard, and durable and free from all deleterious matter, and should not contain flat or elongated particles.

(c) *Water*—Water should be clean, free from oil, acid, alkali or vegetable matter.

(d) *Reinforcement*—Reinforcement should be of steel, which meets the requirements of the Standard Specifications for Concrete Steel Reinforcement of the American Society for Testing Materials. All reinforcement should be free from excessive rust, scale, paint or coatings of

any character which would tend to reduce or destroy the bond.

4. FORMS

(a) *Materials*—Forms may be of wood or metal and should be free from warp, of sufficient strength to resist springing out of shape, and have a width equal to the required thickness of the pavement.

(b) *Setting*—The forms should be well staked and rigidly held in position and their upper edges should conform to the established grades of the pavement. The Conference believes that metal forms are preferable. Where wooden forms are used they should be capped with metal. The forms should be thoroughly cleaned before being used.

5. THICKNESS

The thickness of the concrete pavement is controlled by many factors, such as condition and character of the sub-grade, drainage, traffic, climatic conditions, width of pavement, etc. Three distinct types of cross-sections are in general use:

1. Uniform thickness of concrete for all widths of roads and consequently the same amount of crown in the foundation as in the surface.

2. Roadways in which the concrete is thicker at the center than at the edge, but in which some crown is given to the foundation.

3. Concrete roadways in which the concrete is thicker at the middle than at the edge, but which are built upon a flat sub-grade.

The Conference recommends the latter type for all roadways of 20' or less in width.

6. WIDTH

The Conference recommends that the minimum width be 10' for single track roads and 18' for double track roads. For roads more than 18' in width, it is unnecessary to provide turn-outs of gravel or macadam shoulders, which greatly increase the cost of maintenance.

7. CROWN

Unlike some types, concrete pavements are not damaged by water. If it were not for the need for drainage, a perfectly flat road would be preferable because it would lead to a better distribution of the traffic. Since thin sheets of water or ice on the surface of any pavement are objectionable, a slight crown should be provided to insure drainage of the surface, and the Conference is of the opinion that for country highways a crown of one one-hundredth (1/100) of the width is sufficient. Because of the peculiar needs for drainage in cities, a crown of 1/70 of the pavement width will usually be found ample. On steep grades this crown may be correspondingly reduced.

8. JOINTS

(a) *Width and Location*—It is a well known fact that under ordinary conditions cracks may be expected in plain concrete unless joints are provided at intervals, but such cracks may be prevented or so distributed as to become small and unobjectionable, through the use of sufficient reinforcing steel. Joints are a source of trouble, even if properly spaced and properly constructed and, if possible, should be avoided. These joints necessarily interrupt the continuity of the pavement and are a source of expense in maintenance.

The Conference is of the opinion that where joints are used they should be located at intervals of from 25' to 50',

although under favorable conditions longer sections have been successfully used.

(b) *Protection and Filler*—The joint is preferably protected by two pieces of metal, having high resistance to abrasion, three inches wide and about three-sixteenths thick, between which is placed about one-quarter inch prepared felt of a width equal to the thickness of the pavement.

9. REINFORCING

The Conference is of the opinion that all roads exceeding 20' in width should preferably be reinforced with some form of wire fabric and recommends that the cross-sectional area of the reinforcing metal running parallel to the center line of the pavement should be about 0.038 sq. ins. per foot of pavement and 0.049 sq. ins. per foot of pavement in length, the purpose of such reinforcing being to distribute the effect of expansion and contraction due to temperature changes and moisture content of the concrete, as well as the weight of traffic over defects in the sub-grade.

10. MIXING AND PLACING CONCRETE

(a) *Measuring*—The method of measuring materials for the concrete, including the water, should be one which will insure correct proportions of each of the ingredients at all times. It is recommended that a sack of Portland cement, containing 94 lbs. net, be considered the equivalent of 1 cu. ft.

(b) *Proportions*—The Conference recommends that the proportions do not exceed 5 parts of fine and coarse aggregate to 1 part of cement, and that the fine aggregate should not exceed 40% of the mixture of fine and coarse aggregates.

(c) *Mixing*—Ingredients of which the concrete is composed should be mixed in a batch mixer of approved type, and the mixing should be continued for at least one minute after all the materials are in the mixer. The Conference is decidedly of the opinion that the durability of a concrete road is largely affected by the proper proportioning and thorough mixing of the ingredients.

(d) *Consistency*—The practice is to mix concrete entirely too wet. The consistency should be such as not to require tamping, but not so wet as to cause the separation of the mortar from the aggregate in handling and placing. The concrete, when properly mixed, should have a viscous, plastic consistency.

(e) *Placing*—Just before placing the concrete the sub-grade should be brought to its original surface, if it has been disturbed by teaming or other causes, and thoroughly saturated with water. The concrete should be deposited rapidly in successive batches to the required depth and width of the pavement, in a continuous operation. The section should be completed to a transverse joint, without the use of intermediate forms or bulkheads, or a transverse joint may be placed at the point of stopping of the work. In case the mixer breaks down the concrete should be mixed by hand to complete the section.

(f) *Finishing*—The surface of the concrete should be struck off by means of a template moved with a combined longitudinal and transverse motion. The excess of material accumulated in front of the template should be uniformly distributed over the surface of the pavement except near the transverse joint, when the excess material should be moved.

The concrete adjoining the transverse joints shall be dense and any depressions in the surface shall be filled with a mortar composed of 1 part of Portland ce-

*No material is suitable which is not approximately as hard as flint or quartz. The Conference recommends that an investigation be made to devise a suitable, simple test for hardness.

*The term "hard" as used here refers to the French coefficient of wear; the Conference recommends that the material should have a co-efficient of not less than 12

ment and not more than 2 parts of fine aggregate. After being brought to the established grade with a template the concrete shall be finished, from a suitable bridge, with a wood float, so as to produce a rough plane surface.

(g) *Retempering*—Retempering of mortar or concrete which has partially hardened, that is, mixing with additional materials or water, is strongly condemned and should not be permitted.

(h) *Temperature Below 35° Fahr.*—If the temperature during the progress of the work should drop at any time below 35° Fahr., the water and aggregates should be heated and precaution should be taken to protect the work from freezing for a period of at least 10 days. In no case should concrete be deposited when the sub-grade is frozen.

The Conference is of the opinion that under no condition should concrete road construction be carried on during freezing weather.

11. CURING AND PROTECTING

The curing of the exposed surface of concrete is a matter of the greatest importance. Good concrete can be easily spoiled by too rapid drying out or opening it to traffic at too early a period. It is therefore, highly desirable that the finished pavement should be covered with sand or earth and kept sprinkled for a period of at least 14 days, the purpose of this being to keep the concrete moist, and to prevent the evaporation of the water which is necessary for the proper hardening of the concrete. Where conditions will permit the Conference would recommend that the concrete pavement be not opened to traffic until after an interval of at least four weeks, during which period it shall be protected as above described.

SPECIFICATIONS

The Conference recommends the Standard Specifications for Pavements and Roadways of the American Concrete Institute.

In addition to the Recommended Practice, the Resolutions Committee presented other resolutions, which were adopted, and which in abstract were as follows:

An expression of gratitude to officers, speakers and members of committees for their work in making the Conference an unqualified success and to the Cement

Products Exhibition Co., for the offer made through its president, Edgar M. Hagar, to publish the proceedings of the Conference and of a future Conference if it be held.

The Advisory Committee was empowered to make arrangements for a future Conference, to increase the membership of the committee and the number of its officers and create an Executive Committee.

In view of the desirability of greater knowledge of the materials suitable for concrete roads which exist in the various states, state authorities will be asked to make examinations of materials and proceed with tests of their value.

The Resolutions Committee, which in reality handled the business of the Conference and formulated the Recommended Practice, was made up as follows:

Chairman, Richard L. Humphrey, pres. Am. Concrete Inst., Philadelphia; Secy., Ira O. Baker, professor of Civil Engrg., Univ. of Illinois, Urbana; Members—F. E. Turncanre, dean, Coll. of Engrg., Univ. of Wisconsin, Madison; W. F. M. Goss, dean, Coll. of Engrg., Univ. of Illinois, Urbana; A. N. Johnson, state highway engr., Springfield, Ill.; A. Marston, dean and dir., Div. of Engrg., Iowa State Coll., Ames; Thomas H. MacDonald, state highway engr., Ames, Ia.; James R. Marker, state highway commr., Columbus, O.; Edward N. Hines chairman, Bd. of Co. Road Commrs., Detroit; T. J. Voshell, senior highway engr., U. S. Office of Public Roads, Washington, D. C.; W. K. Hatt, professor in charge, School of Civil Engrg., Purdue Univ., Lafayette, Ind.; Leonard S. Smith, in charge of roads and pavements, Univ. of Wisconsin, Madison; Sanford E. Thompson, cons. engr., Newton Highlands, Mass.; C. W. Boynton, insp. engr., Universal Portland Cement Co., Chicago; F. P. Wilson, city engr., Mason City, Ia.

1—THE CAUSE AND EFFECT OF EXPANSION AND CONTRACTION

The effect of contraction may be finally evidenced by cracking and that of expansion by crushing, spalling or buckling. The engineer is interested in this subject only so far as it affects the integrity of the road. The chief causes of expansion and contraction are:

1. Changes in the temperature of the concrete.
2. Variation in the moisture content of concrete.
3. Variation in the condition and character of the sub-base.
4. Excess loading by traffic.

1. *The Effect on Expansion and Contraction of Temperature Changes in the Concrete*—It is generally considered that the variation in the temperature from season to season tending to cause a change in length, combined with unequal frictional resistance between the concrete and the sub-base, is the primary cause of cracking. The change in the length of concrete due to temperature if free to move, as determined by Bonnicau, Annales des Ponts et Chaussées, Christophe, Le Béton Armé, Sir A. R. Binney, Proc. of Min. Inst., C. E., W. D. Pence, Purdue University, Professor Hallock, Columbia University, Professor Lyford, Worcester Polytechnic, and Professor Norton, ranged from .0000805 to .00004355 per degree F. per unit length, the accepted value being about .00006. Assuming a normal range of temperature of 90 degrees F. the movement which would occur without restraint is about .0054 per unit of length.

In practical work, however, several elements enter tending to modify the temperature effect. A reduction in the moisture content of concrete would cause a contraction while an increase would cause expansion, thus aiding or counteracting the effect of temperature. The friction on the sub-base in the case of a road will always reduce the movement. In some recent experiments made by Henry S. Spackman upon experimental slabs of 1:2:3 concrete 18" wide, 6" 6" long and 6" thick, on a clay sub-soil a total movement of .00017 per unit length was observed under a change in temperature of 65 degrees F. between July and Nov. The theoretical temperature movement for this range would be .00034 per unit of length.

Measurements made by the Bureau of Standards on a concrete road on Morris Turnpike, near New Village, N. J., covering a period from Oct., 1912, to Oct., 1913, and in Nazareth, Pa., from June to Oct., 1913, show that the linear change in the concrete is not in accord with the temperature change.

A variation in the quality of the concrete may also cause a variation in the thermal coefficient of expansion and it will of course affect the movement which takes place, as the modulus of elasticity of the concrete does change with a change in the quality.

2. *The Effect on Expansion and Contraction of Variation in the Moisture Content of Concrete*—It has been definitely established that with an increase in moisture content there is an expansion of the concrete and with a decrease in the moisture content a contraction. This phenomenon is apparently true for all concretes at all ages.

The magnitude of this change is not definitely known but experiments by

1—Contraction and Expansion of Concrete Roads

Committee No. 1 was made up of: Chairman Rudolph J. Wig, U. S. Bur. of Standards, Washington; N. H. Tunnell, civil engr., Davenport, Ia.; W. A. McIntyre, engr., Assn. Am. Portland Cement Mfrs., Philadelphia. Mr. Wig presented the report which contained numerous data on tests in both laboratory and field with graphic presentations of the results by means of tables, diagrams and plotted curves. In the presentation here of this material much has been eliminated with the idea that it is, after all, the conclusions which

are drawn which will be most valuable, so the committee report which is very long, is considerably abridged in its first part.

Your Committee has collated such data as were available on the expansion and contraction of concrete, especially that applicable to roadways, and begs to submit a report in which the subject is considered in the following order:

I. The cause and effect of expansion and contraction of concrete in concrete roads.

II. The application of present knowledge to the prevention of cracks in concrete road construction.

III. Suggestions for further investigation.

Beuschelager, Schumann, Tomei, Consider, Campbell, White and Gary show:

(1) Neat cement hardening under water expands 0.45% by volume and the increased volume is approximately 0.08% for a period of from 30 days to five yrs. The maximum expansion obtained at one yr. is nearly as great as at five yrs.

(2) Neat cement hardening in air contracts 0.25% by volume in from 16 wks. to five yrs.

(3) Cement-sand mortars change in like manner but to a lesser degree. Experiments by the University of Michigan show the following results:

RESULTS OF TESTS OF LINEAR EXPANSION OF NEAT CEMENT STORED IN VARIOUS MANNERS*

Test piece	1" x 1" x 13"	neat cement prisms	
Number of Cements	Manner of Storing	Age of Test Piece	Change in Length Per Unit of Original Length
6	In Water	30 das.	-0.00093
8	In Water	30 to 60 das.	-0.00105
4	In Water	120 das.	-0.00113
20	In Water	6 to 9 mos.	+0.00152
6	In Air	30 das.	-0.00150
13	In Air	30 to 60 das.	-0.00167
4	In Air	120 das.	-0.00211
10	In Air	6 to 9 mos.	-0.00285

*Note:—The original reading was taken on removal from damp closet 24 hrs. after molding.

It was noted that prisms which had been stored in air when placed in water at practically any age began expanding, the expansion proceeding in manner similar to prisms placed directly in water after molding. Similarly prisms stored in water contracted when removed and kept in air.

Investigations have not been extensive enough to form final conclusions on the effect of moisture on expansion and contraction, but the following statements may be made which are in part applicable to concrete roads.

All of the tests quoted above show expansion of neat cement and of mortar and concrete when the samples are hardened under water. The results show the extent of this expansion to be greater with neat cement and to decrease where the addition of sand or coarse aggregate is made.

These tests also show that neat cement mortar and concrete will contract when hardened in air and that the contraction of neat cement is the greater, while that of mortar or concrete varies with the amount of sand and coarse aggregate used in the mixture.

They show that to an age of 20 yrs. and possibly for all time, these changes may be looked for in concrete.

They show that the condition which would provide for a decrease in moisture content when the temperature increases and an increase in the moisture content when the temperature decreases would be an ideal one.

All these tests indicate that the effect of moisture content is very much greater than the effect of temperature change and may be sufficient to cause a stress in the concrete opposite to that which would be caused by a normal temperature change.

A variation in the quality of the concrete will cause a variation in the tendency to expand and contract with change in moisture content, as dense mixtures absorb water less rapidly than porous mixtures.

If concrete of two qualities in a road were exposed to an equal amount of

moisture for a short period, the more porous of the two would have a tendency to expand the most and would have the less strength to resist the stresses set up. Assuming only a slight change in temperature and that the frictional resistance on the sub-base was uniform, the more porous concrete would have to move the greater distance, higher tensile stresses would be set up upon drying out and it would be the more liable to crack.

If one-course work concrete of two qualities in the same slab in a road were similarly exposed, the same tendency would be exhibited and this may, in certain cases, be sufficient to cause a separation of the two concretes or may cause a number of small cracks.

If in two-course work the base is of a more porous concrete than the top, the tendency would be to have unequal expansion and contraction in the slab, due to different moisture content in these mixtures causing the bottom to move more than the top or vice versa. Also if the concrete road is subject to a heavy rain for a considerable length of time the bottom will be exposed to moisture in the ground for a longer time than the surface and the surface will be more or less dried due to exposure to the sun and consequently the top would tend to contract while the bottom would still be expanding.

3. *The Effect on Expansion and Contraction of Variation in the Condition and the Character of the Sub-base*—The condition and character of the sub-base would affect the support of the road; the amount of moisture transmitted to and from the concrete; the action of frost; and the friction on the bottom of the slab. All of these factors affect the expansion and contraction of the concrete.

If the slab of concrete is not uniformly supported, sections may be stressed, causing tension or compression in an amount sufficient to exceed the strength of the concrete, resulting in cracking. A condition illustrating this point may be found where a concrete road is built over an old stone road-bed of less width than that of the concrete slab. The foundation at the sides, which is not so compact as that at the center, will settle more, causing expansion in the surface of the concrete slab possibly sufficient to cause a crack.

The amount of moisture transmitted to and from the concrete through the sub-base depends upon the porosity and density of the material in the sub-base. The action of frost can occur only in a sub-base containing moisture in localities in which the temperature gets sufficiently low to freeze to the depth of the sub-base. This action is therefore dependent upon the porosity and capillarity of the sub-base material and the depth of the water below the concrete. The effect of freezing and thawing is to place the slab in stresses, which may cause cracking.

From observations made it would appear that the cracks usually occur during a thaw rather than during a frost and this may be explained by the fact that the heat may be transmitted more rapidly through the shoulders than through the center of the road, causing unequal settlement. If the heaving action of frost does cause cracking it is usually due to raising the edge of the road, which will probably crack the lower side, which may not be apparent until the slab returns to its original position when the crack will appear on the upper surface.

The friction on the bottom of the slab is dependent upon the condition of the

sub-base. The effect of this friction is to restrain movement in the concrete; therefore the tendency to volumetric change due to change in moisture content and thermal change would be restrained. This restraint would set up stresses in the concrete probably proportional to the restraint.

The longitudinal grade of the road would affect the friction on the bottom of the slab. On a 3.2% grade on Morris Turnpike a slab 30' long was observed to have moved down hill, the joint at the upper end of the slab being decidedly open while the lower end of the slab slid upward on the adjoining slab. The joint in this case was not perpendicular to the slab. Measurements also substantiate the above conditions. This sliding may have been assisted by changes in the thermal and moisture content of the concrete.

4. *The Effect of Traffic on Expansion and Contraction*—The expansion and contraction of concrete are probably less affected by loads brought upon the road by traffic than by any of the above mentioned causes. The effect is, however, not to be neglected, particularly when it acts in conjunction with an uneven settlement of the sub-base, similar to that heretofore mentioned of a slab being placed over an old stone road of less width than that of the concrete. The result would be cantilever or beam action and the consequent throwing into tension the top of the slab, which may cause cracking.

II—APPLICATION OF PRESENT KNOWLEDGE TO THE PREVENTION OF CRACKS

There are a great many factors affecting the expansion and contraction of concrete in concrete roads, and in order to present the available data in a clear and concise form your Committee has prepared a list of questions covering conditions which might arise in the mind of the engineer as influencing expansion and contraction. These questions have been answered in accordance with the available data.

Cracks—Is it possible to prevent all cracking of concrete in roads by a proper application of engineering principles?

Your Committee believes that with a proper understanding of the physical phenomena affecting the expansion and contraction of concrete in roadways, cracking can be eliminated.

(1) When do cracks usually occur? Longitudinal cracks usually do not occur until seasonal changes.

Transverse cracks may occur at any time but the majority should occur during the first dry season.

(2) What is the cause of transverse cracks?

Transverse cracks are probably due to a favorable combination of moisture content in the concrete and atmospheric temperature conditions, together with a restraint induced by the condition of the sub-grade.

They may, however, be caused by an unstable foundation.

(3) What is the cause of longitudinal cracks?

Longitudinal cracks are probably in the majority of cases caused by an unstable condition of the sub-base, although they may be caused by a favorable combination of moisture content in the concrete and atmospheric temperature conditions together with a restraint induced by the condition of the sub-grade. The latter is particularly effective if the sub-base is crowned.

(4) What is the cause of diagonal cracks?

Diagonal cracks are probably most commonly caused by a combination of moisture content in the concrete and atmospheric temperature together with a restraint induced by the condition of the sub-base. In rare cases they may be caused by the above combination and longitudinal restraint along one side when abutting a rough structure.

Effect of Quality on Cracking—(5) What mixture of concrete should be used?

The best mixture is the one which is the most dense and which will reduce to a minimum the absorption of moisture, but it should also have a strength of at least 1,500 lbs. per sq. in. at the end of 28 das.

(6) How should the concrete be mixed? It should be mixed in such a way as to give a product of uniform quality.

(7) How should the concrete be placed? It should be placed in such a manner as to give a uniform quality of concrete in place and to prevent loss of water.

(8) How should the sub-base be treated before placing the concrete?

The sub-base should in all cases be thoroughly wet so as to prevent absorption of moisture from the concrete and thus cause a rapid drying out of the concrete.

(9) How should the concrete be cured? The concrete should be cured in such a way that it will retain its own moisture and receive sufficient moisture until it is strong enough to resist the shrinkage stresses induced by drying out.

Relation of Slab Length to Cracking—(10) What is the maximum permissible length of plain concrete slabs?

The maximum permissible length of slabs, of similar design, on a firm foundation, on a light or flat grade will vary with the climatic conditions. In localities where there is little rainfall, as in Arizona or the San Joaquin Valley in California, the slab length probably should not exceed 25'. This length has been determined by an analysis of a report by A. B. Fletcher, State Highway Engineer of California, on the cracking of a monolithic road, together with a knowledge of the results of measurements obtained by the Bureau of Standards.

In localities where the rainfall is intermittent and the ground water rises in cool seasons and lowers in warm seasons, similar to conditions which obtain east of the Mississippi River, the slab may vary in length from 30' to a continuous slab. While the 30-ft. slab may be regarded as a minimum length, from economical considerations, the results of experiments indicate that cracks are quite likely to occur under certain conditions even in this length.

(11) Does the length of the slab affect longitudinal cracking?

The data available to the Committee would indicate that the length of the slab for the same sub-soil conditions does not affect longitudinal cracking. It is, however, interesting to note that in a report by A. N. Johnson, State Highway Engineer of Illinois, is to be found a statement that in roads constructed by him in 1912 with a total length of 2.3 miles he finds 9.1 slabs per mile, cracked longitudinally, transverse joints being spaced from 30' to 100' apart, on roads 16' to 18' in width. A report of F. F. Rogers, State Highway Commissioner of Michigan, on the Wayne County Roads, shows that on roads constructed in 1912 with a total of 9.6 miles, 9.5 slabs per mile cracked longitudinally, transverse joints

being spaced 25' apart on roads 13' and 16' in width.¹

(12) Is it necessary to vary the length of the slab for concretes of different qualities?

The length of slab should vary with the quality of the concrete. In a short time a denser concrete will absorb less moisture and consequently will have less tendency to move; it will also have greater strength to resist stresses induced by restraint of the sub-base. A dense concrete is particularly of value where subjected to intermittent wetting and drying. In a dry climate where plenty of water is not available for curing the slab length should not exceed 20'.

(13) Should the length of the slab be the same for all sub-soil conditions?

The length of the slab should not be the same for all sub-soil conditions. If the sub-soil is of unstable material the length of the slab must be shorter than for a condition in which the sub-soil is stable.

(14) Is it necessary to vary the length of the slab with a variation in the character of the sub-base?

If there is a distinct variation along the length of the road in the materials of which the sub-base is constructed a joint should be placed where the change takes place. This is necessary because of the change in the frictional restraint offered by different materials and also because of the difference in the porosity which changes the moisture conditions.

(15) Is it necessary to vary the length of the slab with a variation in the condition of the sub-grade?

The length of the slab should vary with the condition of the sub-grade. If the sub-grade could be made very smooth so that more or less uniform frictional resistance would be obtained throughout the length of the slab, it would perhaps be the most desirable condition, but as this is not obtainable it is believed that a more or less uniformly rough sub-grade is preferable to a so-called "smooth" sub-grade. This is explained by the fact that the rough sub-grade will make each small section in the slab care for its proportionate share of the stress induced by frictional restraint, while if the sub-grade is so-called "smooth" there will be rough places in it at intervals which will place upon certain sections undue stresses, which therefore will be more liable to cause cracks. If there is any decided change along the length of the road in the condition of smoothness of the sub-grade a joint should be placed at the point where this change occurs.

If the sub-grade is so-called "smooth" on a steep grade, the permissible length of slab would not be so long as on a light grade, there being a tendency to slide down hill and thus add additional stress to that imposed by moisture and temperate change.

(16) Is the length of the slab dependent upon the grade of the road?

If the grade is steep the slab should be shorter in length than that used on a flat grade. A joint should be placed at all decided changes in grade.

(17) Is it necessary to vary the length of the slab with climatic conditions? See reply to Question 10.

(18) Is it necessary to vary the length of the slab with the season when constructed?

It would appear that the slabs could be made longer if constructed during the fall or winter, in localities where not subjected to freezing, than if constructed in

either the spring or summer, although there are not sufficient data available to determine whether or not this would permit of an appreciable change in length.

Conditions indicate that concrete laid in the fall is probably not subjected to stress as much during the first few months, since the tendency to increase in length due to moisture is counteracted by the tendency to decrease in length due to temperature.

(19) Is it necessary to vary the length of the slab if a bituminous carpet covering is applied?

The experimental results indicate that there was greater movement of the concrete with a bituminous carpet than with concrete uncovered. If, upon further investigation, this condition is found to hold true the slab length would probably have to be varied. The cause for the greater movement noted is probably to be explained by the fact that dark surface absorbs more sun heat and the bituminous coating holds for a longer period any moisture which gets beneath it.

(20) May the length of the slab be made greater for a greater thickness of slab?

The length of the slab may be made greater for a greater thickness of slab. The increased friction caused by increased weight is proportionately less than the increased ability of the concrete to resist stress. Sufficient data are not available to give a relative figure.

(21) Should the length of slab be different for different traffic conditions?

It is not believed that traffic need be considered in determining the length of the slab.

(22) Does the type of joint affect the length of slab?

There would tend to be a greater movement in a wide or elastic joint than in a narrow or unelastic one and since cracking occurs during contraction there would be less movement with a tight joint; a tight joint therefore would permit of a longer slab. It is not known, however, that this factor is sufficiently appreciable to be considered in determining the length of the slab.

Relation of Cross-Section of Slab to Cracking—(23) What is the relative likelihood of longitudinal cracking in slabs of different design but of uniform cross-section?

A concrete road laid on a crowned sub-base would be the most liable to crack longitudinally and on a dishd sub-base the least liable to crack. The resistance offered to contraction of a slab with a crowned sub-base is greater than that offered by either a dishd or a flat sub-base, because the concrete must move against the effect of gravity. With the dishd sub-base the concrete contracts with the effect of gravity and therefore is stressed the least.

(24) What is the relative likelihood of longitudinal cracking in slabs of different design but of non-uniform cross-section?

The cross-section having the greatest thickness at the center with a dishd sub-base would offer the greatest resistance to longitudinal cracking; the cross-section having the least thickness at the center with a crowned sub-base would offer the least resistance to longitudinal cracking.

(25) Does the width of the slab affect transverse cracking?

It is not believed that transverse cracks are in any way affected by the width of the slab. The data available to the committee would indicate that the width of

¹See Oct., 1913, Issue, p. 154—EDITORS

the slab for the same sub-soil conditions does not affect transverse cracking.

(26) Is it necessary to vary the design of the cross-section of the slab with the relative position of the longitudinal drain?

The slab should have its greatest thickness at the center no matter where the longitudinal drain is placed.

(27) Is it necessary to vary the design of the cross-section of the slab with sub-soil conditions?

Over an unstable sub-soil the slab should be made of greater thickness throughout the width than over a stable sub-soil, with the greatest thickness at the center.

(28) Is it necessary to vary the design of the cross-section of a slab with the condition of the sub-grade?

No.
(29) What is the preferable design of cross-sections for different climatic conditions?

The dish is the preferable design under all climatic conditions, especially in arid regions.

(30) Is it necessary to vary the cross-section of a slab with the season when constructed?

The dish sub-base is the preferable cross-section for all seasons and especially so if the concrete is laid in the dry season.

(31) What should be the relation between the thickness at the center and the width of the concrete road?

The wider the road the thicker should be the slab.

(32) Is it necessary to vary the design of the cross-section with the length of the slab?

No.
(33) Is it necessary to vary the design of the cross-section with the traffic conditions?

A concrete road which must withstand heavy and concentrated traffic must be made thicker than for light traffic.

The Value of Reinforcement in Preventing Cracking—(34) When should reinforcement be used?

Reinforcement will be of value—(a) When the foundations are uncertain; (b) In regions where there is little rainfall and long or wide slabs are desired; (c) In regions where there is insufficient water for curing; (d) When it is necessary to have a thin slab; (e) When a decided change in grade occurs; (f) When the movement of the concrete is restrained at street intersections or on curves, if joints cannot be placed properly; (g) When the width of the slab is greater than 25'; (h) When it is necessary to crown the sub-grade and the slab can not be made thicker at the crown than at the sides.

(35) What type of reinforcement should be used?

Only fabricated steel should be used and that form which will give the greatest distribution.

(36) How much reinforcement should be used?

The quantity of reinforcement can be determined only by an analysis of the conditions affecting each specific case.

(37) What is the proper position of the reinforcement in the slab?

If uncertain sub-soil conditions tend to cause a settlement on the sides of the road, which is the most common condition, the reinforcement should be near the top. If settlement is apt to occur within the center of the slab the reinforcement should be placed near the bottom, and where the whole of the sub-base is uncertain the reinforcement should be placed near both top and bottom.

Reinforcement to resist stresses due to temperature and moisture changes should be placed near the bottom of the slab. The stresses set up by a change in temperature are insignificant, except in arid regions, compared with those set up by moisture changes, and ordinarily reinforcement to provide for temperature stresses is unnecessary.

(38) What is the maximum permissible length of reinforced slab?

Your Committee can give no definite answer to this question. The slab length may be anywhere from 20' to continuous depending upon the many elements entering into the problem.

(39) What is the maximum permissible width of reinforced slab?

The widest pavement without cracks within our knowledge is 40'. It is probable that wider pavement can be constructed.

(40) May the slab be made thinner if reinforcement is used?

It would appear that if properly designed a thinner slab may be used if reinforced. Definite information, however, is lacking to exactly determine this fact.

(41) Do the conditions of construction affecting cracking apply to plain concrete slabs as well as to reinforced slabs?

Yes.
The Effect of Joints on Cracking—(42) What is the purpose of joints?

The purpose of joints is to relieve the stress which might be induced by a volumetric change in the concrete caused by change in moisture content or temperatures and to care for unstable foundation conditions. The committee has no evidence of the failure of slabs in concrete roads due to buckling, crushing or spalling and therefore consider the joint as primarily for the purpose of taking care of contraction.

(43) What is the objection to the construction of a concrete road without joints?

If a concrete road is constructed without considering the affecting factors, with the idea that nature will provide cracks, it will crack, but before doing so it will cause a weakening of the concrete for some distance on each side, which may result in a partial disintegration of the road. This is evidenced by short forked cracks appearing running off from the main crack. The cracks thus formed will gradually lengthen with time and will not only be irregular in alignment but they will not be vertical.

(44) Does the width of the joint affect cracking?

The width of the joint controls the longitudinal movement of the slab. A greater width will allow of greater movement, consequently the slab will be more liable to crack upon contracting.

(45) What is the proper width of joint?

A joint should be constructed as a contraction joint with little or no room provided for expansion, as all stresses in the concrete caused by expansion are compressive and may be absorbed by the concrete; later, upon contraction there will be little movement and therefore only small tensile stresses will be induced and there will be less liability of cracking.

(46) Should the width of the joint vary with the length of the slab?

No. Experimental results show that only the movements occurring near the ends of the slab are usually transmitted to the joints.

(47) What is the effect of the filler used?

A filler should not be too elastic to

comply with the conditions set forth in answer to Question 44.

(48) What should be the position of the joint relative to the length of the road?

There are no available data to show the difference in effect of diagonal and square joints on expansion and contraction. Any joint, however, should be perpendicular so as to give proper bearing between adjoining slabs when they expand.

(49) Is it necessary to provide a longitudinal joint between road and adjoining structure?

It is if the adjoining structure is rough and will cause longitudinal restraint or if the abutting structure will not offer sufficient resistance to prevent being pushed out of place.

(50) Should joints be placed at street intersections and on curves in a country highway?

Joints should be placed at street intersections and at sharp curves so as to allow of free movement, wherever the concrete is restrained.

The Effect of Character and Condition of Sub-base on Cracking—(51) Is it desirable to have the sub-grade smooth or rough?

A rough sub-grade is preferable since a very smooth sub-grade is impracticable to construct. (See reply to Question 15.)

(52) Is it desirable to have the sub-base impervious?

The sub-base should be very dense but not entirely impervious. Where a rich mixture is used in the construction of a road it would tend to dry out unduly, causing excessive contraction. If a smooth sub-grade could be provided so that the friction would be reduced to a minimum it might be desirable to have an impervious sub-base, but this condition is very difficult to obtain.

(53) Is it desirable to have the sub-base thoroughly compacted?

It is desirable to have the sub-base uniformly and thoroughly compacted so as to prevent uneven settlement.

(54) Is it desirable to have the sub-base flat, curved or dish?

The sub-base should be dish.
(55) Is it desirable to have the sub-grade roughened on a steep grade?

It would be desirable to have the sub-grade roughened on a steep longitudinal grade.

III—SUGGESTIONS FOR FURTHER INVESTIGATION

In collating this report your Committee found a lack of reliable information necessary to a complete analysis of this subject and would therefore suggest the following problems for investigation:

(1) The determination of the friction of a concrete slab on different materials and under different conditions of the sub-base.

(2) A more accurate determination of the modulus of elasticity of concrete in tension and compression.

(3) The determination of the variation in the coefficient of expansion of concrete when under stress.

(4) The determination of the expansion of green concrete due to the chemical action of the cement during setting.

(5) A more accurate determination of the coefficient of expansion of different mixtures of concrete.

(6) The determination of the effect of change of moisture content in concrete when under stress.

(7) The determination of the bond between steel reinforcement and concrete

when the concrete expands or contracts due to change in moisture content.

(8) The determination of the bond between steel reinforcement and concrete when the concrete expands or contracts due to change in temperature.

(9) The determination of the absorption of heat by concrete uncovered and covered with a bituminous carpet.

(10) The determination of the effect of continual alternate expansion and contraction of unrestrained and restrained concrete.

(11) The determination of the permanent set resulting in wet and dry concrete under various tensile and compressive stresses.

In conclusion, your Committee believes that it has been fully established that the change in moisture content of the concrete is of much greater moment than the change in temperature under normal exposure; and that a proper combination of change in temperature, change in moisture content and friction have made possible the construction of long slabs which have remained free from cracks; while under an unfavorable combination of these factors which is to be found in certain localities, long slabs have invariably cracked. With a proper understanding of the physical phenomena which are recommended for investigation and with a proper application of engineering principles by competent highway engineers, it is believed by your Committee that all expansion and contraction of concrete in roads can be so controlled as permanently to avoid cracking.

2—Joints for Concrete Roads

The report of Committee 2 on Joints is not in complete form at the time of going to press. As presented at the Conference it favored such practice as is already familiar to readers of CONCRETE-CEMENT AGE.

The committee on joints was made up of: Chairman W. K. Hatt, Prof. in charge, School of Engrg., Purdue Univ., Lafayette, Ind.; George W. Cooley, state engr., St. Paul; R. J. Wig, Bur. of Standards, U. S. Dept. of Commerce, Washington. The report was presented by Prof. Hatt and it recommended that joints be termed contraction joints rather than expansion joints; that the joints should be perpendicular to the slab. There was more or less discussion with the jointless road in considerable favor. It was pointed out by H. P. Gillette, Chicago, that a road in California four miles long, 16' wide and 5" thick without joints was, after more than a year, practically without cracks. It was also brought out in the discussion that the use of good, clean, hard materials would greatly relieve the necessity of metal plates to protect joints. The discussion left much to be developed in future practice and the experience accounts were chiefly such as are more or less familiar to all of us. The situation so far as practice in the immediate future is concerned is

best covered in the paragraph on Joints in the Recommended Practice as adopted. This, it is hoped, however, will not discourage experimental work along other lines. The matter of joints is best considered in connection with the report of the Committee on Contraction and Expansion. Mr. Wig, chairman of that committee, advocated a change in the Recommended Practice to provide for one thickness of filler material at joints rather than 1 1/4" of material.

3—Aggregates for Concrete Roads

The Committee on Aggregates for Concrete Roads was made up of:

Chairman, Sanford E. Thompson, cons. engr., Newton Highlands, Mass.; A. N. Talbot, pres. Am. Soc. for Test. Mat., Urbana, Ill. W. M. Kinney, asst. engr., Universal Portland Cement Co., Pittsburgh.

The report as presented by Mr. Thompson in part follows:

The successful development of the concrete pavement depends upon: (1) Materials, and (2) Workmanship.

It is not so much a question as to whether or not concrete is a suitable material for roads in comparison with other paving materials, as it is a comparison between concrete and concrete. The durability depends upon the character of the concrete.

AGGREGATE ESSENTIALS

Simple rules covering the most essential requirements for aggregate are as follows:

(1) For fine aggregate, use only sand or other fine aggregate that has been actually tested for mechanical analysis and tensile strength of mortar, and is free from fine particles.

(2) Use coarse grained sands or hard stone screenings with dust removed.

(3) Use sand or other fine aggregate that is absolutely clean.

(4) For coarse aggregate, use hard stone, such as granite, trap, gravel, or hard limestone.

(5) If bank gravel or crushed stone is used, always separate the sand or screenings and re-mix in the proper proportions.

If local conditions prevent following any one of these rules, adopt some other material than concrete for your pavement.

Briefly taking up each one of these points:

(1) Actual laboratory tests are necessary for fine aggregates, because it is impossible for the most expert builder always to distinguish by appearance between good and poor sands. Sand may be coarse, of good color, well graded, and apparently perfectly clean, and yet because of a minute quantity of vegetable matter may show practically no strength when made into mortar or concrete. Case after case has been found where good looking sand had to be rejected on laboratory test or, if used, produced defective concrete.

Note that two tests are given in the specifications—for fineness and for tensile strength of mortar.

(2) Coarse sand is necessary not only for strength and density, but to prevent the formation, on or near the surface, of a layer of fine material, consisting of a mixture of dust and cement which has no durability. Mortar made with fine sand or sand having a large proportion of fine grains of silt, hardens slowly and is especially objectionable in cold weather. This prevents it attaining proper strength before the road is thrown open to traffic. A sand having a considerable proportion of fine particles may possibly show high briquette tests, and yet the mortar not have good resistance to attrition or wear.

As indicating the necessity for coarse sand, even when the mortar made from it is high in strength, various cases might be cited; one, for example, in Wisconsin, where the sand mixed into mortar showed high tensile strength, and yet, because of 10% of silt in the sand, the surface of the road was entirely unsatisfactory, and had to be covered with a bituminous wearing surface after less than a year's service. A natural sand of limestone composition frequently shows high strength in mortar, but may be poorly adapted to pavements because of an excess of fine grains.

(3) Sand must be absolutely free from vegetable or organic matter, or it is liable to harden not at all or too slowly to be serviceable. Frequently, sand may be entirely satisfactory in appearance, and yet be worthless for concrete. Defective sand of this type is apt to be taken from too near the surface of the ground, so that it contains a very small percentage of vegetable loam. At least 2' of top soil and loam should be removed before using the sand, and in many cases it is necessary to take off as much as 4' or 5', while occasionally no acceptable sand can be found in the entire bank because of the penetration to a great depth of the deleterious vegetable material.

In one case, in Wisconsin, the materials were distributed along the entire length of the road that was being improved. The laying of the concrete was discontinued before the road was completed, and for several months traffic drove over the sand and gravel that was later used in the construction of the concrete pavement. The portion first built was good, while the other part was very defective. The cause of the difference, evidently, was due to the dirt and manure that had become mixed with the aggregate.

(4) A coarse aggregate of hard quality is necessary to resist the wear and abrasion of hoofs and wheels. Failures of concrete roads have been caused simply by the softness of the coarse aggregate. In one instance, for example, shells were used for the aggregate, and the road went to pieces as soon as it was subjected to wear.

All stone, like shale, slate, shells, and soft limestone, must be rejected; while trap, granite, and conglomerate, are especially suitable materials. A hard limestone, such as that occurring in certain localities along the Hudson river, which is sold in New York as trap rock, is satisfactory for concrete roads. A hard limestone cannot be cut with a knife and the specific gravity is high, say, over 2.70.

Gravel does not bond quite so strongly with cement as does broken stone. When properly screened and free from dirt, however, and remixed with sand in the proper proportions, a good surface can be made even for a one-course pavement.

(5) Many roads that are now being built will prove worthless because of the use of sand taken directly from the bank

without screening. If the gravel contains as much as 40% of stones and very rich proportions are used, say 1 part cement to $3\frac{1}{2}$ parts bank gravel, a fair concrete can sometimes be produced, but it is always cheaper in such cases to screen the gravel and remix the sand and stone in proper proportions. There will be, for example, a saving of $\frac{1}{4}$ bbl., or 1 bag, of cement per cu. yd. of concrete by using proportions 1:2:3 cement, sand and screened gravel, instead of using the unscreened bank gravel in proportions 1:3:1. This difference will more than pay for the additional cost of screening the sand and rejecting part of it. At the same time, the result will be more uniform and the surface more durable because of the stones which take the wear. When an excess of sand is used in the mixture, as is the case with run-of-the-bank gravel, the mortar rises to the top when the concrete is placed and the wearing surface is less resistant than a mix that is uniform throughout.

If the rules given above are followed, and at the same time proper foundations, proportions and workmanship are obtained, the concrete pavement will prove durable and will resist ordinary traffic.

The Committee presented specifications for aggregates which were embodied in the Recommended Practice of the conference with two chief exceptions. The committee proposed to limit to 10% the fine aggregate passing a No. 50 mesh. The Recommended Practice as adopted makes it 15%. The committee report would have the coarse aggregate retained on a $\frac{3}{4}$ -in. screen, but the Resolutions Committee made it $\frac{1}{4}$ -in.

4—Preparation and Treatment of Sub-Grade

The Committee on Preparation and Treatment of Sub-Grade for Concrete Roads was made up of: Chairman Ira O. Baker, prof. of civil engrg., Univ. of Illinois, Urbana; A. R. Hirst, state highway engr., Madison, Wis.; A. N. Johnson, state highway engr., Springfield, Ill. Mr. Baker presented the report as follows:

The committee calls attention to the fact that defects in the sub-grade of a concrete road, or the improper preparation of it, may neutralize or nullify the care given to subsequent stages of the construction.

The fundamental requirement of the sub-grade is that it shall at all times be of uniform density, so that it will not settle unevenly and cause cracks in the concrete surface. Some engineers apparently believe that it is not necessary to take as much care in preparing the sub-grade or foundation of a concrete pavement as of other forms of roads having an artificial surface, because the concrete slab will act as a bridge over any soft streak or low spot in the foundation; but the committee is of the opinion that this is a mistake. The strength of a plain concrete slab in acting as a beam to carry the load over a low spot or soft place in the foundation is very slight; and it is so easy to remove the low place

or soft spot as not to justify the dependence upon the beam action of the concrete. Any uneven settlement of the foundation of a concrete pavement is nearly certain to cause a crack. With most forms of pavements a crack in the surface will heal under traffic; but a crack in a concrete pavement not only can not heal under traffic, but will continually enlarge. There is no part of the work of the construction of a concrete pavement that is more worthy of intelligent care and painstaking labor than the preparation of the sub-grade; and the slight additional cost necessary to insure good results is abundantly justifiable.

NEW PAVEMENT ON OLD ROADBED

If the concrete pavement is to be constructed upon virgin soil, that is, if it is not to be constructed on an old roadbed, the precautions usually taken, which are described in the specifications to follow, are sufficient to secure a reasonably good foundation. But if the concrete pavement is to be constructed upon an old roadbed of any kind, either an earth or a broken-stone or gravel road, great care must be taken in preparing the sub-grade. The old roadbed is likely to be more compact in the center than at the sides; and consequently there is danger that the concrete pavement will settle more at the sides than at the center, and therefore will crack longitudinally. Furthermore, it is likely that the traveled way of the old road will not at all places be central under the new concrete pavement, and consequently the latter will settle unevenly and crack.

When the sub-grade is an old roadway, it is not sufficient to roll the sub-grade longitudinally, since the roller is likely to balance upon the more compact central core, and therefore not compress the soil at the side of the old roadway. It is not necessary to attempt a detailed description of the method of overcoming this difficulty; but the engineer should be alert to determine whether or not this condition obtains, and when it does occur he should take the necessary precautions to secure a thorough consolidation of all parts of the new roadbed. It may be necessary to add material at the side of the more compact central core of the old roadway, or it may be wise to roll the roadway diagonally or perhaps transversely. In extreme cases it may be necessary to loosen the old roadbed by spiking or scarifying, and then harrow it, and finally consolidate the entire new roadbed with the roller. The Committee desires to assert emphatically that the need of care in this matter is not imaginary, and that such conditions do really occur in actual practice.

DRAINAGE

The drainage of the roadbed of a concrete pavement is of vital importance. If the sub-grade is not well drained, there is danger that after the concrete is laid, the drying of the soil under the edges of the concrete may permit the pavement to settle and thus cause longitudinal cracks on the surface. Further, if the sub-grade is not well drained, there is a possibility that the frost may lift the edges of the concrete roadway and cause a longitudinal crack, at least on the lower side and possibly also upon the upper surface of the concrete. It is hardly possible in a report of this character to give detailed instructions for the adequate drainage of the roadbed for all kinds of soil and for all conditions, but a few remarks may be permissible.

If the soil is sandy, there is a possibility that the natural under-drainage is sufficient for the purpose.

If the soil is only moderately retentive, it will probably be sufficient to lay a line of ordinary farm tile along each side of the concrete pavement. The tile should be laid at least 1" or 3" in diam., should be laid $2\frac{1}{2}$ " to 3" below the surface, and should have sufficient fall to free itself promptly and fully. It is better to lay the tile outside of the edge of the concrete slab than under it. If the soil is a little retentive, some engineers put a layer of coarse gravel or broken stone immediately above the tile to facilitate the entrance of the water into the tile.

If the soil is quite retentive, it is wise to make more elaborate provisions than above for the drainage of the sub-grade. For this case, it is recommended that a shallow longitudinal ditch be constructed just outside of the edge of the concrete slab. This ditch should extend about 8" or 10" below the surface of the roadbed, that is below the bottom of the concrete slab; and should be filled with coarse gravel or broken stone. From this longitudinal ditch short transverse ditches should be dug across the shoulder to the ditch at the side of the roadway. These transverse trenches should have a grade sufficient to permit them to carry the water promptly and fully to the side ditch. In particularly retentive soil, these transverse trenches should not be placed more than 50' apart. On level stretches, these transverse ditches should be practically at right angles to the direction of the road; but if the road is on a grade, these trenches should make an acute angle with the roadway, the amount of this angle depending upon the grade of the road. The sloping of these lateral trenches down hill makes it necessary to have the ditches at the sides of the roadway as deep as would otherwise be required. These lateral ditches should be filled level full with broken stone or coarse gravel to a point at least a little beyond the outer edges of the shoulders and preferably nearly to the bank of the ditch at the side of the roadway.

SPRINKLING THE ROADBED

Possibly the following item is more properly included in the instructions for laying the concrete; but it is mentioned here in order that it may not be overlooked. Before the concrete is placed, the roadbed should be thoroughly saturated with water. This precaution is particularly important if the ground is dry or the soil is sandy.

Specifications for sub-grade were presented by the committee but are here omitted.

5—Reinforcement

The Committee on Reinforcement, made up of: Chairman, Thomas H. MacDonald, state highway engr., Ames, Ia.; Henry E. Riggs, prof. civil engrg., Univ. of Michigan, Ann Arbor; Richard L. Humphrey, pres. Am. Concrete Inst., Philadelphia, did not complete its report at the time of the Conference. It is to be completed later and embodied in the proceedings.

(Conference Reports Con'd on page 146)

March, 1914

Concrete Economical for Road Construction if Only for Foundation Value

By C. J. BENNETT³

The following is an abstract of an address by Mr. Bennett before the Assn. of Am. Portland Cement Mfrs. at its recent meeting. Mr. Bennett's views of concrete as a road material are extremely conservative and therefore are of especial interest. He does not expect the concrete surface to remain good very long but nevertheless firmly believes the construction to be economical.

We are faced with two great problems: First, the construction of new roads in undeveloped sections; and, touching briefly on this particular point, those roads must be built with a view to the future, that is, with the elimination of excessive grades, with the elimination of bad lines, and widening out to what might possibly be considered excessive widths, so that the future traveler may not be discommoded as development comes. The second problem, in which we are more particularly interested for our present needs, is in the roads which are at present built in some form or another, passing through more or less thickly settled farming country or through country residential property. On these roads there has been so much development by the abutting property owners that it is practically impossible for us to change the line, for us to eliminate bad grades, and almost impossible, in a good many instances, to widen out the road. These roads supply the greatest problem now, and on those roads we must design or have designed for us a proper surface which will take care of the travel at the present time and which will take care of the future travel, which must of necessity be considered as vastly in excess of the present in point of number of vehicles, in point of weight, and I think in the point of speed.

It seems to me that there is no question at all that the concrete road is the solution of our difficulties. We feel in Connecticut that what little work we have done—we put down only 10 miles last summer—has indicated to us that the concrete road is the solution of our problem. We do

not go to the extent of the enthusiast who says that the concrete road is going to last for all time; that it seems to me, is rather broad, radical statement to make; but we feel that the concrete road, properly constructed, can be used for a more or less extended length of time, say four or five years, and then that surface which may be worn out by excessive travel which has passed over it, may be a foundation for some more permanent pavement, whether it be bituminous, whether it be brick or granite block in certain instances. That, it seems to me, is a very sensible view to take of concrete as a road material; feeling that there is no question whatever that concrete has its own stability and has the most valuable asset in this strength and resistance to stresses of all kinds in a future foundation.

CAREFUL SELECTION OF MATERIALS

We are probably all aware of the great many failures in roads built of concrete; and I think that the failures made in the past have caused a great many road builders to go extremely slow in the construction of concrete roads, whether for foundations or for wearing surfaces. To my mind the failure of concrete for road purposes has been mainly due to lack of care in construction and selection of materials and in the proper grading of the materials. To some extent it has been due to the fact that there has been considerable lack of uniformity in Portland cement. I have some particular evidences of that in my own mind, which are failures of concrete—not for roads either, but failures of concrete which have been due to the cement; and that can be proven absolutely, so that I think my statement is fair, that some failures have been due to the cement itself. However, the most of them have been due to lack of care in the selection of the other materials and in the construction itself.

In Connecticut we are exceptionally fortunate in having a large amount of very good trap-rock available in almost every section of the state. Where we have no trap-rock we have excellent gravel. That makes it possible for us to build concrete roads at I think a very low

cost. In selecting the material for these roads from this trap-rock, taking first the larger aggregate, we consider that the greatest care must be taken in grading the material, so that we get the proper selection of different sizes to decrease the voids. In selecting the sand there is need of still greater care. We had some rather unfortunate results last summer in the selection of our sand in Connecticut, owing to presence of some material in the sand itself which caused the retarding of the setting of the cement, possibly, or stopping the setting altogether in some instances. What that characteristic on the part of the sand was I do not know. It has been ordinarily considered, I think, by engineers that casual inspection of the sand, rubbing it in the hand and washing it in a milk-bottle, will suffice; but we have not found that to be true. It is quite necessary to take a great deal of care in the sorting and selection of the sand itself, even so far as to have a chemical analysis in the laboratory.

After the material is properly graded and the mixture is decided on, we have found that you cannot neglect the proper measuring of the aggregate before mixing. Our work has all been done, after the first piece of work, by using boxes for measuring sand and stone.

The sub-grades must be carefully prepared and free from any inequalities and where the drainage conditions are poor sub-surface drainage must be applied in just the same manner as for any other road. The matter of drainage, of course, is vital to the concrete road just the same as to any other road. The mixture must be carried out and placed with great care so that the larger material does not run in bunches, so to speak. It must be uniform, and great care taken if there is a little inequality in the mixture.

After the road has been placed, taken its initial set, we score the surface with brooms. That is a matter of construction; after that scoring is done we are very anxious and very careful to see that the concrete road is covered with some sort of material to allow the road to season throughout at about the same rate; and this covering material has been kept wet in many instances at considerable expense on account of the lack of water, and the concrete in the road allowed to set slowly and evenly. The length of time of setting will, of course, vary on account of weather conditions. Recently we have been letting these roads stand for three weeks in the summer-time. When the weather was good and we

³State Highway Commr., Connecticut

had a sufficient amount of water to wet the surface, we let the traffic over the road after seven days; and in no case have we had any trouble from letting it over too soon.

Just a point as to the price on the road. We have been very fortunate within the past six months in getting advantageous prices for concrete roads. We recently let a contract for a gravel concrete (where the gravel has to be screened) 6" thick, for 68 cts. per sq. yd. That is abnormally low. We have built a road of trap-rock concrete for 89 cts. per sq. yd., a little over a mile of it. We have received bids for others up as high as \$1.33 per sq. yd. That is just for the concrete road itself. Now taking the average, slightly over a dollar, the ordinary macadam road 7" thick, built without any binding material other than water, cost us an average of 65 cts. per sq. yd. The bituminous, with a 5-in. loose stone foundation, filled with sand and carth, a protection of about 2½" on top, cost anywhere from \$1.25 to \$1.45, a trifle over the cost of concrete. The macadam cost for repairs the first year (assuming that the repairs consist of applying a bituminous flush coat) possibly 15 cts. per sq. yd.; the second year 5 cts. per sq. yd.; the third year 8 cts. or 10 cts. per sq. yd.; and the fourth year somewhere near 20 cts. per sq. yd. These figures are not exceptionally high, I think. With these figures we can demonstrate, of course, that it is far cheaper to build a concrete road if we do not have to put very much maintenance on it for four years. After that fourth year with the macadam road we have practically to rebuild it entirely, so that we have at the end of the fourth year our assets in the concrete foundation, even if we do have to put our bituminous or brick top upon it and we can save money by building a concrete road.

[Editors' Note—Reference to figures on Wayne county concrete road maintenance elsewhere in this issue, coupled with a little computation on a square yard basis, goes to show that the maintenance on 51 miles in 1913 was about 1½ ct. per sq. yd., not including a cost of 9 cts. per sq. yd. for some poor surface which was covered with bitumen.

On the bituminous road, repairs begin as soon as it is built. Within two weeks after the completion of a bituminous road we have had to go on with repairs. With the patented bituminous roads, we find that repairs are needed possibly far in excess of what would be required for the concrete road itself, and we do not have the foundation. Therefore

it seems evident that the concrete road is the one to build.

We have had experience both with tar-paper filled joints and the metal protected joints; but in my opinion and the opinion of men who are actively engaged in the construction of these roads the tar-paper filled joint is just as good as the other. That may sound like a strange statement, but a reinforced joint adds to the cost of the road something like 5 cts. or 6 cts. per sq. yd. With the tar-paper joint the cost is so low that it is almost negligible. The tar-paper joint needed pointing very shortly after it was put in, but the cost is the same and it lasts just as long as the same work which has to be done where metal joints are used, and it does not approximate six cts. per sq. yd. So it seems to me that the tar-paper joint properly applied, and properly filled with tar-paper, leaving the tar-paper to stick up a short distance and for the traffic to hammer into the joint, so to speak, is a very satisfactory and safe joint.

I think much of our present trouble in road construction is due to the lack of definite joints. The reason given at present for not putting them in is attributed to the claim that every joint is a weak spot in the paving, making a place to be worn away by wheels and horses' shoes. However, the writer is convinced that until an expansion joint is used, and at the same time one that will not be materially weaker than the main part of the pavement, concrete pavements are not going to be successful pavement in those sections of the country where there is a wide range in temperature.—J. G. WICKHAM, City Engr., Ames, Ia.

Lynn, Mass., Lays Concrete Paving Without Joints

The accompanying illustration shows a concrete pavement being laid in Lynn, Mass., 32' wide, with no expansion joints, either transverse or longitudinal. The mixture used is 1 part Knickerbocker¹ cement, two parts Plum Island sand, and 4 parts crushed stone. Neither of these materials was washed. The surface of the pavement was finished without using a template. The pavement is 8" thick at the center and 6" thick at the gutter. From George H. McPhetres, Commissioner of Streets and Highways, we learn that the city of Lynn has been doing all its own street, sewer and sidewalk work for the last two years. The first of the concrete paving of the kind mentioned was put down in 1912. Mr. McPhetres says:

It is laid without lateral or longitudinal joints and we have yet to find drawbacks because of their absence; in fact, the worst piece of smooth paving in the city is one with joints laid by a private contractor. The streets paved are heavily trafficked. The average cost has been approximately \$1.25 per sq. yd., sometimes more, sometimes less, varying with the length of haul and the difficulty of excavating material. This year cement cost \$1.36 per bbl., sand 72 cts. per cu. yd. and stone 80 cts. per ton.

Before a job is settled it is important that executive organization for the work should be well considered. A change in superintendents while the job is under way makes for unsatisfactory conditions, higher labor cost and inefficiency in general.

¹Knickerbocker Portland Cement Co., Hudson, N. Y.



LAYING CONCRETE PAVEMENT IN LYNN, MASS., WITH NO JOINTS

Concrete Bridge Construction by the St. Louis Park Department

Concrete is being used to a large extent by the Park Dept. of St. Louis, Mo. Among the structures built of this material are the two bridges in Fairground Park and the recently completed bridge over the storm water channel in Forest Park.

At the time of the World's Fair, which was held in a part of Forest Park in 1904, the storm water channel referred to above was transformed into a covered wooden flume 10' wide x 10' deep. Recently the Sewer Dept. decided to construct a uniform channel for the water, and the ditch was again opened except at a point where the "World's Fair Drive" crosses the channel.

Plans were drawn for a bridge to carry the drive over the channel, and the work of constructing the bridge was placed under the construction division of the Park Dept. Work on the bridge was begun Aug. 4, 1913. The first step was the wrecking of the remains of the old flume while the structural and architectural details were being prepared in the construction division.

It was decided to use reinforced concrete beams with reinforced concrete floor slabs. The clear span was 30' and the bridge was designed to support a 12-ton roller concentrated load and 100 lbs. per sq. ft. over the balance of the floor of the bridge. The main girders were constructed 3' deep x 18" wide, reinforced with 1 $\frac{1}{8}$ -in. round high carbon steel bars. Shear bars of $\frac{5}{8}$ -in. round were used. A very good idea of the placing of the steel may be obtained from Fig. 1.

The floor slab was 9" thick and reinforced with $\frac{1}{2}$ -in. round rods, 7" o. c. and $\frac{5}{8}$ -in. round rods 9" o. c.

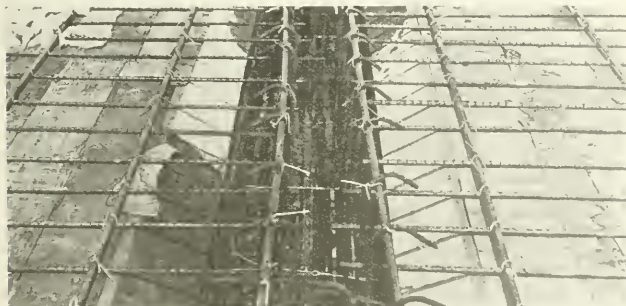


FIG. 1—DETAIL VIEW SHOWING GIRDER REINFORCEMENT IN BRIDGE BUILT IN FOREST PARK, ST. LOUIS



FIG. 2—RUNNING THE FOOTINGS AND FOUNDATION WALLS, FOREST PARK BRIDGE, ST. LOUIS

The old flume is shown in the foreground

over the top of the beam into the slab to take the negative bending moment.

Fig. 3 shows the foundation and abutment work. In making the excavation it was found economical to do most of the excavating by teams with wheelers. After the excavations were made, a heavy rain caused the banks to cave in and the Park Dept. then suffered its only set-back in the construction of the bridge. The ditches had to be re-opened. This was done with wheeled scrapers.

The hand rail and the balustrade are of open construction, which allows free course of air within the lines of the bridge and eliminates

which have been such a great detriment in bridges of this kind. The sides of the balustrade are of stucco, bringing out to great advantage the architectural detail.

In handling and placing all the concrete, a gasoline-driven batch

wind whirlpools and flying dust, mixer¹ was used. The mixer was elevated enough so that the material was placed by means of chutes, directly from the mixer. The best day's record made on this work was 250 batches of concrete. The mix used in the floor slab was 1:2:4, using cement,² Meramee river sand, and $\frac{3}{4}$ -in. limestone.

A Surface Finish 9 Inches Thick

On a big industrial building, now nearing completion in Detroit, the builders have adopted an almost radical method of overcoming top finish troubles. The floor is a flat slab averaging 9" thick and as the concrete is poured it is straight-edged and carefully floated and troweled by experienced finishers, leaving a smooth, uniform surface, with the least amount of soft cement at the top. It is truly a concrete surface, and the same method, which has been tried out previously, has worked out very well indeed. It is an interesting departure from accepted practice along this line.

¹"Chicago No. 16," Chicago Concrete Machinery Co., Milwaukee.

²"Red Ring"—Union Sand and Material Co., St. Louis, Mo.



FIG. 3—POURING THE FLOOR STRUCTURE ON A BEAM AND GIRDER BRIDGE, FOREST PARK, ST. LOUIS

Concrete Stone From an Outside Viewpoint

Under the title "Synthetic Stone," the *Engineering Record* discusses, editorially, concrete stone—the place it has filled and is likely to fill as follows:

Hitherto the word synthetic has savored of the smells of the chemical laboratory and has perforce summoned up visions of the alembic, the crucible and the beaker. The successes of chemists in producing by long and painstaking experimentation substances which had formerly been thought creatable only by processes of Nature have justly had wide publicity. Synthesis, therefore, has been acquiring a strong chemical affinity. But a few engineers and manufacturers of building materials have been steadily developing and perfecting a material which, because of its excellence, should be distinguished in name from concrete, to which it is related as to its ingredients. Synthetic stone is a fitting designation for it.

For approximately 20 years concrete made with special care or by unusual processes has been on the market in this country under such indefinite and confusing names as artificial stone, cast stone, concrete stone, granite composite and imitation limestone. Partly because of such misleading names the material has been confounded with concrete blocks, so heartily despised in certain quarters,

and with cast-in-place concrete, but little better liked for architectural construction in others. But a few concerns, at least, have for a number of years been producing stone which for appearance, strength and other qualities compares favorably with good limestone, sandstone and granite.

In some particulars the synthetic stone has advantages over the natural. It has not the same limitations as to sizes and shapes and is much less subject to damage by fire. It is less expensive, for if a pattern is repeated there is a material saving which cannot be secured with cut natural stone. Intricate shapes can be made with relatively less increase in cost than in natural stone, the material is less subject to some kinds of stain, while some injuries can be perfectly repaired, which, if suffered in a natural stone, would be inforced with steel according to the uses and shapes of the blocks, and by this means many unsightly cracks, which often occur in lintels and similar members of natural stone, are avoided. It can be cast in the shop and transported after finishing—the more common practice—or cast in place in the building and finished subsequent to the operations which might soil or deface the walls. In some instances savings can be effected in transportation charges because the stones can be made thinner, or because less waste or surplus material is required.

Surfaces of synthetic stone can be tooled in almost, if not quite, every way that the surfaces of natural stones can be tooled; moreover, there are certain special treatments not applicable to nat-

ural stone. In texture and color many natural stones can be so closely simulated that a close inspection, even by persons familiar with such materials, is necessary to differentiate the artificial from the natural product. Tales are told of architects who have specified natural granites to match existing synthetic stone, all unsuspecting the nature of the earlier material. In addition, effects in color, texture and finish can be obtained which are not practicable with the natural hopelessly. It can be, and usually is, restones. On the other hand, there are certain indescribable accidental variations of tone and texture in some kinds of the natural product which are beautiful and desirable but which, up to the present time, the most skillful manufacturers of synthetic stone have been unable to reproduce or equal.

In density, strength and freedom from absorption results are constantly attained which command respect. Weights of 140 lbs. to 155 lbs. per cu. ft. testify to the density; compressive strengths of 6,000 lbs. to 10,000 lbs. per sq. in. have been shown by tests; absorption as low as 4% by weight in 48 hrs. can be specified, and as low as 1% at the age of 24 mos. is claimed. Its durability is attested by examples which for nearly 20 years have resisted weather and wear under severe conditions. Side by side with granite, in steps, sills and trimmings, some of the best synthetic stone has endured equally well, at least so far as surface inspection can determine.

Unfortunately, however, the record has not been uniformly good for all material



FIG. 4—THE COMPLETED BRIDGE ACROSS THE STORM WATER DITCH, FOREST PARK, ST. LOUIS

for which places in this class have been claimed by makers or sales agents. Some have been distinctly inferior in materials and workmanship, and consequently disappointing in appearance and durability. Possibly stone of such quality has been good enough for less expensive buildings, and its price may have been sufficiently low to compensate for its inferiority. Some examples closely approach common concrete and give to the beholder the unpleasant impression usually conveyed by an evident and unsuccessful imitation.

Having observed that not a few engineers and architects were uninformed as to this useful building material and its possibilities, it has seemed worth while to bring it to their attention. Doubtless many men of both professions have repeatedly passed excellent examples of synthetic stone in more or less prominent structures in many cities and towns without having once suspected that it was not natural stone. Those who, having heard of it, instinctively think of its cost in figures which they have grown accustomed to apply to common concrete will soon be disillusioned when they attempt to buy it. But when the saving as com-

pared with natural stone is considered, or when it is recognized that the desirable qualities of stone can be secured for edifices for which the expense of natural stone is prohibitive, the claims for economy in the use of synthetic stone are justified. Before specifying it, however, the engineer or architect should learn the details of manufacture, so that he may not unwittingly increase the cost to no useful purpose.

Concrete Roads in Andover, Mass., As An "Experiment"

Early last fall the Massachusetts Highway Commission built about a mile and a half of concrete road 19' wide in North Andover, on the road leading from Lawrence through Middleton to Danvers and Salem. The general mixture used was 1:2:4 on most of this work, using clean, sharp sand and a good quality of stone from $1\frac{1}{2}$ " to $1\frac{1}{4}$ " in size. A large

part of this work was done with Knickerbocker Portland cement, but the Highway Commission put down various sections with other cements and will make careful observations of the difference in results, if there is any difference. A further change was made in the mixture on a part of the work to determine whether or not a richer mix would give better satisfaction. On a part of the road, a mixture of $1\frac{1}{2}$:3 was used. The general specifications for mixing and laying and so forth on this road are not unusual. It will be noticed, however, from the accompanying illustration, that the crown of the road is unusually high, and referring to the surface, thickness and crown, A. W. Dean, Ch. Engr. of the commission, writes as follows:

"The surface of the concrete was finished by floating and using a template, thereby obtaining an absolutely uniform section and smooth surface. After the surface had set very slightly, a broom was dragged lightly across it in order to rougher it somewhat. No bituminous covering was used. The concrete was placed 6" thick on about one-half the length of the road, a crown of $1\frac{1}{2}$ " to the ft. being given to the sub-grade and consequently to the surface. The other half of the road was constructed 5" thick at the sides and 7" thick at the center, with a crown of $1\frac{1}{2}$ " to the ft. of concrete surface."

The illustrations show what seems to be unusually neat work. The contractor was the David J. Sheehan Co. The upper view shows in the foreground the pavement which has been gone over with a broom and in the background some of the older concrete covered with earth. The lower view shows the operation in finishing the surface.



TWO VIEWS OF WORK ON CONCRETE ROAD, ANDOVER, MASS.

March, 1914

Wire in Place of Chalk Line

In laying out construction work, lines are usually strung between batter boards. Some contractors use wire for the main lines and find it satisfactory. A light wire, about 18-ga., can be used satisfactorily. The only trouble is that the wire rusts and is practically wasted, and some contractors might not consider its use an economy.

On the other hand, on lines of great length, the wire stretches less and can be pulled so much more taut. An ordinary cord has to be taken in at night to both save it and to prevent it from shrinking and snapping in case of a rain. Wire, however, can be put up once and left up until its use for that particular line is past.

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

How Does Hydrated Lime Add to the Strength of Concrete?

DISCUSSED BY S. B. NEWBERRY¹; E. W. LAZELL²; BERNARD ENRIGHT³

"In general, tests show that the additions of hydrated lime to Portland cement mortar up to about 10% (by weight) increase the strength of the mortar. Leaving out of consideration the fact that lime increases the density of mortars, rendering them more waterproof and smoother

to work, how in detail does the lime act to augment the actual strength of the mortar? Can it be considered that the hydrate adds its own strength to the strength of the mortar, less a certain proportion of the greater strength of the cement which it replaces?"

By MR. NEWBERRY

In regard to the action of hydrated lime in increasing the strength of cement mortar or concrete, I would say that any finely divided inert substance thoroughly mixed with the cement will aid in closing voids and increasing the density of the concrete. This would in itself result in some increase in strength. There is no doubt that hydrated lime has also some hardening power of its own and some chemical action in the direction of developing the full activity of cement in crystallization and hardening. Its effect on blast furnace slag, in imparting a strength which the slag itself would not show at all, is well known, and a similar action undoubtedly takes place, of course to a much smaller extent, in admixture of lime with Portland cement.

The chief benefit from use of hydrated lime is in concrete which is to be exposed to air, rather than in concrete kept under water. I understand that hydrated lime is of little or no benefit in concrete which is

kept constantly wet. For air-mortar, used in laying up brick or stone, mixtures of cement and lime are most useful. The addition of about 20 lbs. cement to a bushel of lime gives a mortar which becomes surprisingly hard.

By MR. LAZELL

In general it may be stated that the denser the mortar or concrete, the greater the strength, other factors being equal. This fact is, I think, generally admitted. If, then, hydrated lime increases the density, the strength of the mortar or concrete must be increased. The question therefore resolves itself into proving whether or not hydrated lime increases the density.

It is well known that mortars composed of Portland cement and sand are harsh working and non-plastic, that is, they are not easily molded or troweled. These harsh mortars require considerable manual work to mold or to form into any given shape. The addition of hydrated lime overcomes this harshness, rendering the mortar more plastic. It must therefore follow that the same amount of manual labor in molding or troweling will produce a denser mass.

In the writer's opinion, the great-

est advantage of the use of hydrated lime is this quality of rendering the mortars more plastic, the increased plasticity resulting in greater density. Exactly the same argument applies to concrete. Concrete containing a small amount of hydrated lime is much more plastic and smoother working than similar concrete containing no hydrate. Because of this greater plasticity the same amount of tamping would result in a denser concrete.

An illustration of the increase in plasticity of concrete, due to the addition of hydrated lime, recently came to the writer's observation. In the construction of a large dam in the Northwest, the quarry and rock-crushing plant were located on a hill-side, about 400 ft. above the river. Since no good grade of sand was available, the fine part of the aggregate was manufactured from the rock. The concrete mixing plant was also located on the hill, above the crest of the dam, and practically all the concrete was spouted into place through chutes about 285 ft. long, which had an inclination of 18°. In this manner about 30,000 cu. yds. of concrete was placed. The concrete used was a 1:3:5 mix, using cement, sand and stone, with an addition of 10% hydrated lime.

Without the addition of the hydrate, the wet concrete would not flow in chutes, but would dam up and then spill over the side. With the addition of hydrate, the material flowed smoothly and there was very little separation of the mortar from the stone. Throughout the construction of the whole dam, test cylinders were made, 6" in diameter x 12" long, and these were broken at regular intervals. These cylinders were made at the site of the dam from the material being deposited. The result showed a considerable improvement both in the quality and the strength of the concrete, due to the hydrated lime.

¹Pres. and Gen. Mgr., Sandusky Portland Cement Co., Sandusky, O.

²Edwards and Lazell, Cons. Engrs., Portland, Ore.

³Director, Eastern Testing Laboratories, Allentown, Pa.

It is hardly possible, in concrete used below grade, where it is constantly wet or damp, that hydrated lime directly contributes to the bond of the mass, that is, there is probably no chemical combination in which the hydrate plays a part that directly contributes to the strength of the mass. The part played by the hydrate is wholly mechanical, imparting greater density to the concrete. It is further a well known fact that lime paste tends to retain its mechanically mixed water, thus hydrated lime retards the drying out of both mortar and concrete and supplies the water necessary for the full development of the strength of the cement. This quality of hydrated lime is particularly valuable when used in cement mortar, since the affinity of the hydrate for water keeps the mass damp and allows the cement to gain its full strength.

By MR. ENRIGHT

There is no question as to the favorable influence exerted by a small proportion of hydrated lime in giving plasticity to cement mortars and concrete mixtures, facilitating the working of the mass, the flow of the concrete and the tendency towards fewer voids and a denser mixture. Its consequent tendency towards waterproofing is also well known.

In regard to the question of strength, cement mortars are, of course, at least three or four times as strong, both in tension and in com-

pression, as hydrated lime mortars, and the substitution of hydrated lime for a small portion of the cement would naturally work towards slightly less strength, were there no compensating advantages either in the physical condition, as pertaining to the density of the mass, or of some reaction between the hydrated lime and the cement.

The fact that experiments show that the increase in strength noted in mortars to which a small proportion of hydrated lime has been added is generally with mixtures with a high percentage of voids, while cement and graded sand mixtures with a minimum of voids show but little effect or even a slight diminution of strength on the substitution of a small proportion of hydrated lime, seems to indicate that in general the favorable effect of such addition lies principally in the increased density of the mass.

Hydrated lime, however, also acts as a retarder on quick setting cement. It is a well known fact that "breaking the set" in handling concrete made with cement which tends to set before the mass is placed in position, very materially weakens the resulting structure. In a case such as this, the addition of hydrated lime, by retarding the set so that the mass can be placed before the initial setting of the cement takes place, will result in a structure of at least normal strength, as opposed to the former abnormally weak result.

Seventy-two parts boiled linseed oil, six parts iron sulphate, four parts zinc sulphate. Heat these materials together and boil for several hours. (Possibly to dissolve the iron and zinc sulphate, although on this we are not positive). When cool mix with sixty parts oil of turpentine and apply as a paint.

The Problem of Plastering Concrete Walls □

DISCUSSED BY C. R. KNAPP¹

"I have been building concrete culverts and cellar walls and have had trouble with plastering surfaces. Sometimes I plaster the walls green and sometimes dry. Sometimes the plaster on the green walls checks and cracks and sometimes the plaster on the dry walls cracks. What is this due to and how can I remedy it?"

By MR. KNAPP

In regard to the problem of plastering concrete walls, I should say that in all probability the plaster is allowed to dry out too quickly. This will cause cracking. Or it may be that the plaster is too rich, causing contraction. On a green wall the contraction in the wall and in the plaster would be unequal.

I think my first suggestion is the solution,—the plaster should be kept damp even on a green wall. On a dry wall, the wall itself must be well soaked so as not to draw out from the plaster the water needed to cause it to set properly. When a crack is starting it should be touched up again with a float or brush.

EDITORIAL DISCUSSION

While cracking of mortar-plaster may be due to the mortar being too rich in cement, to the dryness of the wall plastered, or to the sun and wind removing moisture from the mortar surface, it has always seemed to us that the best means to prevent cracking of cement mortar applied to concrete surfaces is *not to plaster*. Better, neater and less expensive results can be obtained by building the forms neatly, by proportioning aggregates correctly, and by spading the concrete next to the forms so as to produce a mortar surface on parts visible. Facing boards likewise can be used for the same purpose. After the forms are removed, slight irregularities can be removed by rubbing with a carborundum stone or a cement brick. Then there is no checking of the surface.

Treating Canvas for Steam Room Curtains □ □ □

DISCUSSED BY A. E. CLINE¹ AND C. W. BOYNTON²

"With what preparation shall I treat canvas doors used at the ends of steam curing chambers, so that the doors will keep the steam in and at the same time remain sufficiently pliable to roll up easily?"

By MR. CLINE

I have had experience with but three methods of using canvas curtains, viz., plain canvas and treatments of boiled linseed oil and some patent waterproofing especially made for canvas.

The boiled oil was the most successful of the three, the plain canvas next and the waterproofing last. With

the last named preparation the canvas rotted in one-third the time that it did when untreated. With the boiled oil, the canvas curtains remained flexible and lasted for about four months, when they had to be renewed. Steam seems to be very hard on canvas; it will not last very long in any case, but the curtains are handy, not expensive, and generally preferable to doors for the inside ends of the steam rooms.

By MR. BOYNTON

We understand that the Techno-Chemical Recipe Book by Grant and Wahl, page 386, describes a material for waterproofing sail cloth which we believe might be used to advantage in this case. The preparation is as follows:

¹Peekskill Cast Stone Co., Peekskill, N. Y.

²Universal Portland Cement Co., Chicago

Construction and Layout of Steam Rooms in Products Manufacture

DISCUSSED BY CHARLES E. SIMS,¹ C. W. BOYNTON,² A. E. CLINE³

"What is the ideal construction for a curing system in a plant where the products to be manufactured include drain tile, building block, fence posts and ornamental work? By the kind of system we mean: 1, How large should the kilns be built? 2,

Is it better to have them two-track kilns or one-track? 3, What is the best construction for walls and roof? 4, What is the best system for piping the supply of steam? 5, What is the best door construction?"

BY MR. SIMS

I will answer the questions submitted, basing my answers on the results of the last five and a half years' experience manufacturing drain tile, block, posts, etc., but feel that other manufacturers should argue some of the subjects because other ways have been successfully tried.

In building a new plant I would favor kiln room sufficient to accommodate three days' production of tile of any size. Each manufacturer must determine for himself the room required, because he will get a production larger or smaller than another manufacturer according to the ability displayed in operating the plant. In ordinary use we find cars 36" or 40" wide and 8' long. One hundred cars will suffice in some plants, where 150 are required in others. The curing rooms should be of tunnel shape to accommodate one track each and 10 cars in a tunnel are as many as should be allowed. One track is preferred to two or more because cars can be run in and out without exposing the tile on any other track to cold or drying winds before they are ready to be taken out of the kiln.

Concrete block make a durable wall for a kiln and are the best construction for the money. Such a wall can be made wind- and steam-tight. I would make the outside walls of the kilns of concrete block with an air space throughout the wall, and the inside or partition walls of half the thickness—say 4". The roof can be made by casting semi-circular slabs of reinforced concrete and putting them on the walls so as to form an arched roof or, better still, can be made using a ribbed expanded metal, plastered with cement mortar on both sides of the reinforcement

so as to form either an "A" roof or an arched roof. A flat roof is not desirable because the condensation which takes place on the under side of the roof should be made to run off to the side walls rather than allowed to drip at random from the flat roof and spoil freshly made products.

In putting on the "A" type or the arch type roof, attention must be given to tying the walls together with tie-rods every 6' or 8' in the length of the kilns. A wooden roof is cheaper than the reinforced concrete but does not keep in the heat so well. We should aim to maintain a uniform temperature in our kilns at all times when curing the products and this requires attention to the construction of the kilns as well as to the supply of heat. If the roof were made double, with an air space of a few inches between, it would be better still, but I would not use wood for this, for it rots too rapidly to make it pay.

Two systems are in use for delivering steam to the kilns. One pipes the steam from the engine exhaust, or from the boiler direct, or both, to wells in the floors of the kilns. These wells may be built by setting 20-in. or 24-in. tile in the center line of the kiln so as to have one under the track at every other car; the bottom is cemented and the sides washed with cement and water to make them cistern-tight. The steam is piped to the outlet near the bottom of each well with a valve to regulate the flow, and the wells are kept full of water. By this means an even distribution of very moist steam is obtained and sprinkling of the products is rendered unnecessary.

The other system is to use a boiler with open pipe to each kiln, the steam passing freely from boiler to kilns as generated. The only objection to this system is that the steam is not so moist as with the first method, and requires more attention from the fireman. It is good prac-

tice under either of the above systems to run the steam in until a temperature of 80° to 110° is obtained. I think we ought to maintain the temperature as nearly as possible at, say, 80° or 90° day and night, though I know many factories obtain good results without a night fireman. We use here in the summer a large boiler which gives off steam all night long, but in winter we employ a night engineer.

The best door construction, to my mind, is the wooden door hinged at the side. A trial of canvas doors has proven unsatisfactory from the standpoint of durability. Matched flooring makes a good door and such a door can be fitted tightly enough if some attention is given it after it has become thoroughly wet from the steam.

The kilns should be large enough to let in the loaded cars and allow sufficient width so that men can work around them. The head room should be no more than is deemed necessary to clear the products on the cars, as we want to hold the heat down to the curing products and do not want to waste it by having too much space to heat up.

It is necessary to have a transfer track at both ends of the curing rooms. These tracks should be housed so that the products being moved may not be exposed to the weather when first made and so that drafts of air will not enter the kilns. It is well to tack cloth sacks to the bottom of each kiln door still further to exclude drafts.

BY MR. BOYNTON

1—The word "kiln" suggests a room for drying, accordingly, it is better to substitute "steam curing chambers" for this word. The size of the chambers will, of course, depend directly upon the size of the manufacturing plant and the daily output. The entire steam curing capacity should be large enough to accommodate two days' manufacture. If the plant is run continuously there should be two steam curing chambers to hold succeeding days' outputs. This is necessary because specifications state that 48 hrs. of steam curing is advisable. With two chambers, handling a day's output will not interrupt the continuous curing of that of the previous day. This assumes that the curing is carried on night and day.

In a plant where several varieties of concrete products are produced on a large scale, in general a saving of labor and a consequent plant economy should result from a separate handling and curing of the several varieties. However, in small plants

¹Worthington Concrete Tile Co., Worthington, Minn.

²Inspection Engr., Universal Portland Cement Co., Chicago

³Peekskill Cast Stone Co., Peekskill, N. Y.

where the time of the factory operations is divided in the making of a small number of several different kinds of products, it would undoubtedly be more advisable to cure each day's output of all the products in one chamber, as this would reduce the cost of the steam curing structure by reducing the number of walls, doors, pipes, etc.

2—Whether to have two-track or one-track curing chambers depends primarily upon the size of the plant. If the capacity is large enough a two-track room will be more economical than two one-track rooms in the saving of partition wall and also as a saving in floor space would result from decreasing the distance between the outside walls, by the use of a two-track chamber instead of two adjoining one-track chambers with a partition between.

3—The selection of the material for the construction of a steam curing chamber should be based upon the idea of producing a permanent and air-tight building. Wood is liable to rot from constant contact with hot, wet atmosphere or if the steam curing chamber immediately adjoins the plant proper the whole structure, in case wood is used, is liable to destruction by fire at any time. If this occurs in the rush season it will result in a loss not only of the factory itself but also a further one due to the necessity of discontinuing factory operations until another structure can be built. Concrete construction, either monolithic or block, is advisable for steam curing chambers, as the various requirements of fireproofness, airtightness and permanency are all met by this material. Concrete block construction in the past has been very popular for such use.

As to the shape of the roof, the concrete "A" roof, set upon concrete block walls, tied across the top, has been recommended in the past. An arched roof made by concreting over metal lath bent to the required shape has been proven very desirable. The object in the selection of either shape is to produce a roof which will not permit water, resulting from the condensation of steam, to drip back upon the product which is being cured and thus damage it, but a roof which will drain the water to the edge whence it will run down the walls and across the sloping floors back to the water trough.

4—A good system of piping the supply of steam is to set a perforated steam pipe into a trough of water running throughout the length of the curing chamber. This device will necessitate a flow of the steam

through water before coming in contact with the products and thus obviate any possibility of the latter being dried out.

5—Any type of door construction which insures air-tightness and which facilitates opening and closing can be used. Oiled canvas attached to a roller at the bottom, so that it may be raised or lowered when desired, instead of opening out, supplies the requirements for a suitable door for the steam room.

BY MR. CLINE

Without fully knowing the local conditions of a plant, its situation and the relative proportions of each product to be manufactured, one can write in general terms only and leave it to the interested parties to apply the suggestions, as each plant has its own peculiar problems.

Each kiln for steam curing should be large enough to take care of one day's run; whether that would mean a kiln for each product, for two products or for all products made in one day, depends entirely on local conditions—size of plant and its output.

As concrete products should remain in the kilns at least two days, this means three kilns for each, or for all products as is necessary.

In length 80' to 90' is enough for a kiln, as it is difficult to force low-pressure steam much further. Have the curing chamber as low as possible, though high enough to cover the highest load that will enter them—usually 7' in the clear will do it, and 10' or 12' wide, which will in most cases provide for three tracks. This I like better than one track, as with a system of several kilns the empty cars can be returned through the kilns, and so one does not need an extra storage track.

There is nothing better than concrete for walls and roof—light hollow block or tile for walls and a curved roof (to avoid drip) over each kiln, using some good expanded metal bent into shape and covered with a good cement stucco.

I have made good kilns with two thicknesses of 1½-in. lumber and a layer of cold-storage insulating paper between them, but of course this has not the lasting qualities of concrete.

For steam supply, the simplest way is to have a main pipe over the top of the kiln doors; then lead from this a separate 1½-in. pipe to each kiln; run this along one of the walls close to the floor, but with slant enough to drain to the farther end. Join each length with a tee having the third hole of the tee reduced to

1½", and turn this at right angles to the wall. The 1½-in. pipe can be reduced to 1-in. at half length of kiln; this is on the supposition that the kiln is 80' long.

If using steam for power, have this main pipe connected with the exhaust during the day, and with the boiler at night. If the boiler pressure at night is greater than 10 lbs., it is best to have a reducing valve in the main line as a high pressure is not wanted—just steam.

The construction of the doors is not a very important item as I do not believe in having the kiln too tight; some air admitted helps condensation and prevents too great a heat. Two thicknesses of matched boards or even shiplap with insulating paper between, and fitted with ordinary refrigerator fastenings answer very well for the outside. For the inside, curtains that can be fastened on the sides with board strips and then rolled up when kiln is being filled, make a good arrangement and are handy.

Effect of Salt Solution on Concrete Reinforcing

EDITORIAL DISCUSSION

"I have used a 2% solution of calcium chloride and a small amount of common salt to prevent freezing in my own work on plain concrete, but heretofore have never cared to use salt solutions in reinforced concrete work as I understand that this is liable to be injurious to the steel reinforcing. May we have further discussions of this question?"

Relative to the effect of the addition of salt to reinforced concrete the Bur. of Standards, Washington, D. C., advises that if a structure is to be continuously exposed to moisture, the addition of calcium chloride or common salt may be injurious in that it greatly accelerates the corrosion of the embedded material where exposed to stray electric currents. In the upper floors of concrete buildings which are not exposed to moisture the addition of salts would probably have no effect as the concrete would be a good insulator. In mass concrete the addition of a small quantity of salt has no effect in so far as we have been able to determine by physical test. Technologic Paper No. 18, of the Bur. of Standards, on "Electrolysis in Concrete" will give further information upon this subject.

Contraction Joints in Sidewalks

DISCUSSED BY:

J. Q. WICKHAM¹; EUGENE P. ETZEL²;
C. W. BOYNTON³; KENVON RIDDLE⁴

"Why is it necessary to cut a sidewalk into slabs every 5' or 6'? What is the relation between the width of the sidewalk and the spacing of the contraction joint? Would it not do just as well to place a contraction joint every 20'? Should not sidewalk practice parallel the best method of handling the same problem in concrete road work?"

By MR. WICKHAM

The reasons some of us give for cutting sidewalk into slabs every 5' or 6' are that it is not only to give a chance for expansion and contraction to some extent, but principally to do away with unsightly cracks that would appear, running in almost any direction, due to shrinkage on setting up or slight settlements of foundations. As it is, these cracks will come at the weakest points, that is, where the sidewalk is cut, and leave, therefore, no unsightly irregular cracks.

The writer has seen some instances, one right here in our own city, where the walk was not properly divided into blocks and where a crack, starting at one street, extends in a very irregular line the entire length of a block. If the division between the blocks had extended clear through the walk, this crack, if it had appeared, would not have been at all unsightly, as it is now.

The relation between the width of the walk and the contraction joints can be computed in this section of the country (using a 1:3½ or 1:4 mix) because we have learned by actual construction that our 13-ft. walks here on Main St. have expanded about 6" per block, and unless an allowance is made in the width of the walk in the same proportions as is allowed in length of walk, unsightly cracks are most surely to appear.

No, it would not do just as well to make contraction joints every 20' for the reason that in our experience here (others may not have had the same trouble) it is practically impossible so to distribute the stresses that are set up in a block of such

size that contraction cracks will not show. One need not be limited to the minimum size of slabs other than by appearance, as too small a slab gives the appearance of being "choppy" and does not present so good an appearance.

It might be mentioned also that small slabs are more apt to settle out of shape, and therefore it is usual practice to make as large a slab as practicable that will stand the contraction strains. This size with present construction is now thought best in slabs from 4' to 6'.

By MR. ETZEL

Relative to question of contraction joints in sidewalks, I shall try to explain the matters embraced in the question from a practical rather than a scientific point of view.

1. It probably is not necessary to cut a sidewalk into slabs every 5' or 6', but experience has shown that it is a very advisable and desirable practice to do so, to insure uniform, good appearing and lasting work.

2. Practice has also established that in general sidewalk slabs shall not exceed 36 sq. ft. of area, and the thickness of the concrete shall be in number of inches whatever the average width of the slab is in number of feet.

3. A sidewalk is a sidewalk, and a road is a road,—this in a nutshell is a homely but simple reason why it is unnecessary to build them both in the same way. A sidewalk is not usually subjected to the wear and tear that a road gets and is not intended to be. Modern competition demands as cheap a job as possible, compatible with utility and satisfactory service, and as present methods of laying sidewalks are producing generally good results, there is no reason for following concrete road practice in laying concrete sidewalks, as each class of work has its separate standards and uses.

By MR. BOYNTON

Before discussing the foregoing questions it is best that we correct a mistaken idea. Sidewalk joints spaced at intervals upwards of 6' and referred to as contraction joints in the foregoing questions are in reality not contraction but construction joints, spaced so that each slab will be of sufficient strength to with-

stand, as a unit, the variable forces to which it is subjected. A length of slab must be chosen so that the walk will not develop cracks due to transverse stresses.

Our experience in sidewalk construction leads us to believe that the best results are obtained when a sidewalk is laid in slabs having an area not to exceed 36 sq. ft. and when the length of any slab is not more than 1½ times the breadth.

Since the prevailing factor in the design of a sidewalk on earth or cinder foundation is that the cost shall be a minimum, we must eliminate from our consideration reinforced concrete and confine our discussion to comparatively thin, plain concrete slabs. These slabs are generally laid upon newly made fills which in time settle more or less unevenly. There is an occasional root lying near the surface of the foundation and the earth under the sidewalk is apt to be unstable, owing to insufficient drainage. Considering these conditions true, it is evident that the reaction of the foundation will not be uniform over the entire area, but that at times slabs will be subjected to cantilever, simple and continuous beam action.

A multitude of practical demonstrations proves the wisdom of using the sized slabs recommended herein. Where in pavements the limiting spacing of expansion joints is controlled in part by the foregoing mentioned forces, the spacing of sidewalk expansion joints is controlled only by the compressive strength of concrete and the amount of expansive movement. The joints, therefore, may be spaced farther apart. We find that the best results are obtained when slabs are laid abutting each other in sections of 50' divided by 1½-in. expansion joints at each end. These joints should be filled to the surface with a material which will allow freedom of expansion.

Sidewalk design parallels that of highways but the limiting conditions of the two types are similar in a general way only. With pavements, the traffic is rolling, therefore, joints are objectionable, whereas the rolling load on the sidewalk is not worth consideration, and neatly constructed joints are not an inconvenience to pedestrians.

By MR. RIDDLE

Were sidewalks built under the same conditions as concrete roads are, they could of course be handled in the same way. Since they are not, however, it is not necessary that they be built to stand the same usage and, since the material and proportions

¹City Engr., Ames, Ia.²Treas., F. W. Gibbs Contr. Co., Montclair, N. J.³Engr. in Chg. Information Bur., Universal Portland Cement Co., Chicago⁴City Engr., Abilene, Kans.

are generally inferior to those used in concrete roadways, they will not resist the tensile stress produced by contraction.

Also, external temperature changes do not affect the internal portion of larger masses as they do in smaller ones. These joints not only guard against cracks caused from changes in volume, but they allow for irregular settlement of the structure. In concrete roads every precaution is made to insure adequate foundation and even bearing capacity, such as

sub-drainage and a thoroughly compressed sub-grade. In addition to this preparation, the greater strength and area of the road pavement overcome the possibility of settlements that might be expected in sidewalk work.

In conclusion, it might be said that the spacing of the joints would depend upon the bearing capacity of the soil, tensile strength of the concrete, area of the pavement and weather conditions at the time the concrete is laid.

Sodium Silicate Solution for Concrete Floors □

DISCUSSED BY ALBERT MOYER¹

"Does a water glass solution make a good concrete floor dressing for residences and public buildings? Will it prevent dusting? How is it put on?"

By MR. MOYER

There is no question that if this "water glass" or sodium silicate solution is properly applied it will do away with the dusting of concrete floors. We know this from our own personal experience. When we came into the office that we now occupy we found the dust to be unbearable. That was about four years ago. We applied "water glass" solution about as covered in the following paragraphs and now the floors do not dust at all. Directions in detail follow:

HOW TO APPLY WATER GLASS ON CONCRETE FLOORS

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush, removing all dirt and loose particles. Allow the surface to dry, and as soon as dry apply a mixture or solution of 1 part water glass (sodium silicate) of 40° Baumé, and 3 parts to 4 parts of water, depending upon the porosity of the concrete. The denser the concrete, the weaker the solution required. Stir well, and apply this mixture with a brush. A large whitewash brush with long handle will be found most economical.

If this solution is sufficiently thin, it will penetrate the pores of the concrete. Allow the concrete surface thus treated to dry. As soon as dry, wash off with clean water, using a mop. Again allow surface to dry and apply the solution as before. Allow to dry and again wash off with clean water, using a mop. As soon as the surface is again dry, apply the solution as before. This should fill all the pores and the third coat will entirely flush all over the surface. If not, apply another coat as above.

The sodium silicate which remains on the surface, not having come in contact with the other alkalies in the concrete, is readily soluble with water and can therefore be easily washed off, thus evening up the color and texture of the floor. That which has penetrated into the pores, having come in contact with the other alkalies in the concrete, has formed into an insoluble and very hard material, hardening the surface, preventing dusting and adding materially to the wearing value of the floor.

An electric railroad in California is using pre-cast concrete units for constructing waiting rooms.

¹Sales Mgr., Vulcanite Portland Cement Co., N. Y. C.

Insulating Values of Structural Materials □ □ □

DISCUSSED BY PETER NEFF¹

"We are planning to build a storage warehouse and want to know the comparative insulating values of concrete, stone and brick. We shall appreciate what information you can let us have on this and would like especially reference to a standard text-book on refrigerating plants."

By MR. NEFF

The thermal conductivity of walls of brick, concrete and stone has not been very definitely determined, but all three materials are very poor when viewed from the insulation standpoint. In other words, their conductivity is so high that they are practically neglected and other insulation is always figured on. Therefore, for the purpose of cold storage, the question as to what type of material shall be used will depend on other considerations.

Architects as a rule have made a mistake in the past in believing that because they were architects they were familiar with the problems of refrigeration and have undertaken at times to plan cold storages and breweries, which are not good from the standpoint of the refrigerating engineer. A combination of architect and engineer will make possible the working out of these problems to produce the best structure at the least cost.

Recently, a set of architect's plans came under my supervision after they had been completed, and I found that the amount of insulation shown was the same for all rooms no matter what the temperature or purpose of any particular room might be. There was also a total disregard of the proper location and sizes of doors required. In this case I could not alter the arrangement of the

rooms but did cut out some of the doors and proportioned the insulation and was able to save my client in the neighborhood of \$1,000. This was on a comparatively small installation.

As to text-book of the industry, probably the best thing is the "Compend of Refrigeration,"² but even this is apt to mislead those unfamiliar with the industry. The U. S. Bur. of Standards is at work on the determination of some of our basic standards which we hope will help to unify the industry. Last year they determined the latent heat of ice, which is one of our main bases.

A book could be written on cold storage construction, but it would all be summed up in the statement that each case must receive its own treatment and be considered from all points of view, which, when properly done, will solve the question of what material should be used in a given building.

Concrete construction is now very common in cold storage work, and when properly executed makes a good building.

I want to lay stress on the point of arrangement of rooms. This should be so that the cost of doors and insulation is reduced to a minimum.

There are three parties whose ideas must be blended into one result: the owner, with his ideas of the uses of the building and its arrangement for the proper handling of the work to be done in it; the refrigerating engineer, who must provide for the continuous economical operation of the refrigerating equipment; and the architect, who must consider the exterior design, and the economical construction.

¹Specialist in Refrigeration, Canton, O.
March, 1914

²Published by Nickerson & Collins, Chicago

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellows." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellows."

Measuring Cement for Small Batch Mixers

Editors' Note—Small batch mixers are meeting a real need in the economical handling of concrete work and one of the problems of present-day field practice is the best way to measure the cement when less than a sack per batch or a sack and a fraction per batch is required.

As bringing further light on this subject the following letter from a mixer manufacturer is of interest. The letter is, indirectly, a very good argument for the use of bulk cement, and the use of scoops to handle cement.]

In my opinion the measuring or dumping of cement from sacks directly into any mixer is never practical nor economical unless the batches mixed are large enough to permit the dumping of one whole sack full of cement into the batch.

I have had many years of experience in the building of country highway bridges, together with considerable experience in concrete foundations, walls, etc., and it is my opinion that in all cases where less than one sack full of cement is to be used to the batch it is always better and more economical to dump the sacks of cement out into a measuring or scooping box and then dip the amount out of this box with a measuring scoop so as to get the exact proportion for each batch with but very little delay.

In every case where cement is

dumped from the sack direct into the mixer, the workman dumping the sack of cement invariably delays the other operators of the machine. He stands to dump out and shake out the sacks and in almost every instance will delay the whole crew from $\frac{1}{4}$ minute to $\frac{1}{2}$ minute if not longer. This is never the case where cement is scooped out of a storage box and into the mixer by a measuring scoop of some kind.

We have tried to pound this theory into the heads of some of the old-timers but they tenaciously stick to the idea of measuring from a sack as if there were not possibly any other way. It is nothing but a habit on the part of the workmen and cement users and the papers should investigate this point and try to overcome this serious waste of time and the making of ununiform concrete.

The U. S. Govt. engineers on their work absolutely refuse to permit any such method of measuring and their stand in this matter is well taken. They insist that the cement be measured in a special box or measuring scoop so that the quantity in each case is correct and that is absolutely the only proper way to measure cement.

In the last 10 years, the selling price of cement has gone downward more or less steadily. In the same time, the selling price of concrete buildings, also, has decreased.

Why Does Concrete Occasionally Fail?

A LETTER FROM CLARENCE N. WILEY¹

Cement companies are trying to make the best cement they can, but there is no doubt that at times a cement fails to pass the ordinary boiling test, and the user wants to know why.

Every precaution is taken to turn out the best cement possible, but is there any process of mind or matter which does not go wrong at times? Let, for instance, a testing engineer with his own hands make briquettes from a sample of cement. He has perhaps made three or five briquettes from the same paste or mortar which he declares to have been uniformly conditioned. At the end of seven days, he breaks these briquettes. The results may vary considerably depending on his experience. Why should they not all break under the same strain? Possibly he has a mechanical reason to explain this, but why, then, did he not control this process step by step so that absolute uniformity would exist in the results? Possibly he may say that this could have been done were it not for a personal factor over which he had no control. Ah! Can he guarantee to eliminate this factor? Well, hardly.

Thus in the mechanical manipulation and chemical combination of two or more materials which enter into the manufacture of a Portland cement, we not only have mechanical and chemical idiosyncracies to overcome and control but we have that

¹Mgr., Northfield Iron Co., Northfield, Minn.

¹Gen. Mgr., Atlantic and Gulf Portland Cement Co., Ragland, Ala.

bug-bear of science—the personal equation. Working on small quantities of raw materials in the laboratory, it is possible and by no means difficult to produce repeatedly a perfectly balanced cement. When the quantities of these materials are increased to terms of hundreds of tons, when their chemical composition may vary from hour to hour, when the stone may be harder in this batch than in the one an hour later, when the miller may carelessly feed too much material through his mills or the burner carry too low a heat in his kilns, and a hundred other “ifs” and “whens,” variation is bound to result and it is to guard against these irregularities that the modern cement manufacturer is obliged to employ trained men as chemists and engineers.

But through the handling of large batches, it is possible to maintain an uniformity not possible with relatively smaller batches. A bin of cement may contain 1,000 bbls. of cement which will not pass the specifications for fineness but mixed with this are 10,000 bbls. of finely ground cement and when the bin is emptied, it is found that the coarse cement has been so intermixed with the fine, that all passes the specification. If a sample is taken of this coarse cement as it issues from the mills, it may fail on the boiling test, but would this be sufficient reason to condemn the entire bin?

Again a few hours' run of clinker may be “high in lime.” If this be ground before it seasons, the cement may fail on the boil. A few days' seasoning in the air corrects the effects of this excess lime and the cement is sound. Is this seasoned cement to be condemned because it did not boil at first? So there are many reasons why an absolutely uniform product may not be obtained from hour to hour and from day to day and for this reason it is necessary that certain specifications be adopted which good cement must pass. If the manufacturer offers a cement which will not pass these tests, then it is right that he be censured, for it is his business to know before he ships it whether or not his product is up to specifications.

We manufacturers are not interested half so much in the reason why it is not uniform as we are in ways and means by which we can overcome these factors which cause non-uniformity. Of course we have much to learn on the phenomena of the hardening of cement and this is being slowly worked out. Perhaps at some future time, the manufacture of cement may be reduced to such a scientific basis that the personal equation may be eliminated but by this time engineers may also know why their structures fail when on paper they have proven that they can not fail.

The entire pavement was covered and kept wet for a period of two weeks, after which it was cleaned off and the east half of each section was covered with a layer of asphaltic oil, on top of which was placed a layer of stone chips varying in size from $\frac{1}{8}$ " to $\frac{1}{4}$ ". The ends of the pavement are protected by a metal plate $3/16$ " by $2\frac{1}{2}$ " and anchored into the concrete with large spikes which fit snugly in holes drilled in the plate.

After being in use about six weeks the concrete shows no bad effects of its rough usage. A small chuck hole has developed in the dirt at either end of the pavement and the heavily loaded wagons strike the pavement with a heavy bump, but so far no damage has been done. Also some small pieces of gravel are usually found on the pavement which have fallen off the loaded gravel wagons and in many cases the wagons have run over these small stones and crushed them, without any apparent injury to the concrete. However, when this has happened on the oiled portion of the pavement, the oil has been destroyed over a spot 1" or 2" in diameter, depending on the size of the stones which were crushed. There is no apparent harm which can be seen with the eye, but the oil can be picked off with the point of a knife or a stick, leaving the concrete surface absolutely bare. At first the oil seemed to adhere firmly, but already it is possible to peel it off from spots of considerable size, and I do not regard this part of the experiment as a success. In regard to the plain concrete surface, sections No. 1 and No. 2 have been entirely satisfactory, but I believe section No. 2 has a finish which is better suited for a concrete pavement. In placing the stone chips on section No. 3, a great many of them were not embedded deeply enough in the mortar and were soon loosened. However, I believe that if these stone chips are properly put on they can be made to adhere properly, and I believe will provide a very good wearing surface.

As the pavement has been down a short time only, I do not think conclusions as to its success are justified as yet, but so far it has been all that could be desired.

A new experiment on a much larger scale is now being planned, which will be carried out within the next few months. Jefferson St. is to be paved with bitolithic pavement from First St. to Seventh St. The block between First St. and Second St. is occupied on the north side by the City Hall Plaza and the City Coun-

Concrete Paving Experiment at Phoenix, Arizona

A LETTER FROM F. M. HOLMQUIST¹

On account of the demand on the part of numerous property owners for concrete street pavements, I thought it advisable to construct a small sample so that they could see for themselves just what this class of work is like and so that the best method of finishing the surface could be decided upon.

A location for this sample was chosen on one of the principal streets, over which a very large amount of traffic passes. This traffic includes, besides automobiles and light wagons, a large part of the sand and gravel which is hauled into the city from Salt River.

The piece of pavement is 20' wide by 30' long, divided into three transverse sections, each 10' long.

The concrete was made 1 part cement, 2 parts sand and $3\frac{1}{2}$ parts of screened gravel. Section No. 1 was struck off with a template and finished with a wooden float. Section No. 2 was struck off with a template, smoothed with a wood float and given its final finish with a coarse broom. Section No. 3 was struck off with a template, tamped with a tamper composed of bars spaced about $\frac{1}{2}$ " apart, driving the coarse parts of the aggregate beneath the surface and leaving about $\frac{3}{8}$ " of mortar on top. A layer of stone chips passing a screen of $\frac{1}{2}$ -in. mesh and retained upon a screen of $\frac{1}{4}$ -in. mesh, was then placed on the surface. These stone chips were thrown on with considerable force so that they were partly embedded in the mortar and firmly adhered to it.

¹City Engineer, Phoenix, Ariz.

cil has instructed that the north half of this block shall be paved with concrete and the south half with bitulithic. Jefferson St. being an east and west street, this will provide one-half of the roadway concrete and the other half bitulithic. This street is 68' wide between curb lines, which will make the concrete portion 34' wide. Specifications for this job have not as yet been prepared, but will, in all probability, call for a 1:2:3½ mix, and reinforcement of wire mesh, surface finished with a broom, and metal plates at the edges of the pavement along the bitulithic.

This block of pavement will be very near the center of the business district and will be subjected to a great deal of heavy traffic.

Relation of Strength to Temperature of Green Cement

A LETTER FROM E. L. CONWELL¹

The article by Warren A. Hoyt on "Relation of Strength to Temperature of Green Concrete," which appeared in the Jan., 1914, issue, p. 19, is of considerable interest, and Mr. Hoyt is entirely correct in his suggestion that the question should be taken up by some of the testing laboratories with a view to establishing better practice in the use of concrete in cold or freezing weather.

The setting or hardening of cement is essentially a chemical reaction and as such is quite sensitive to the influence of temperature changes. In the case of some chemical reactions, a drop of 10° C. in temperature causes the reaction to take place at half the original speed. Such a ratio has never been established for cement, since the rapidity of the chemical changes taking place during hardening is very difficult to measure, but it is established that the hardening of cement proceeds much more slowly at temperatures approaching freezing and ceases or nearly ceases when freezing temperatures occur.

Mr. Hoyt's table, in which he shows the growth in strength of concrete day by day at varying temperatures is, however, open to criticism. For example, on the eighth and the ninth day, which had freezing temperature, he considers that the concrete does not gain in strength, while on the 10th day, the tempera-

ture of which was 36°, he concedes a small increase in strength. It would appear logical that after two days of exposure to freezing temperature, the mass of the concrete would not on the third day warm to a point above freezing. Indeed it is a question whether or not the interior of the concrete would thaw for several days unless the temperature rose to a notable extent. Considering small masses of concrete, which while green are exposed to freezing cold, it would appear that the water mechanically contained in the hydrous silicates and aluminates formed in the process of setting would freeze to crystalline ice, while the water chemically combined with these silicates and aluminates would have practically no activity below the freezing point. On the return of higher temperature, the whole mass would thaw and the water on returning to the liquid condition, would again take part in the setting action. The return of freezing would cause a cessation of the setting action until a thaw came, so that the influence of alternate freezing and thawing on green concrete would cause alternate setting and retardation of setting.

A further influence is the expansive force of the water at the instant it is transformed into ice, which would have a disruptive action and probably cause weakening of the mass. If this latter theory is correct, mortar or concrete should give much better results when laid in extreme cold weather and allowed to freeze and stay frozen until a permanent thaw comes than if it were exposed to alternate freezing and thawing; and general experience substantiates this. Whether or not freezing and thawing bring about a complete stopping of the set and starting of a fresh set, or causes a mere suspension of the set is open to question. It might be pointed out, however, that it frequently occurs that the surface of concrete exposed to freezing peels off to a depth of 1½" and it is possible that the portion which peels off, which usually has no strength whatever, really freezes and the strength, due to whatever set may have taken place, is broken by the expansion of the water. In this way, the portion that peels off may have acted as a protective for the interior, so insulating it as to save it from freezing and consequently from disintegration.

Recurring to Mr. Hoyt's article, it is our opinion that very conservative values should be set down for the gain during alternate freezing and thawing, because every one versed in the use of cement knows

the unreliability and feeble character of third, fourth, fifth, etc., sets of a given cement mortar.

This subject, is one, however, which would bear careful investigation, the result of which would undoubtedly save each winter much financial loss and destruction of human life.

Concrete's Appeal to the Architect

A LETTER FROM HENRY LORD GAY¹

I look over all the publications on concrete that I get hold of and treasure up the interesting parts that appeal to me. You have a fertile field in the world of construction to work in, for the possibilities of concrete, from the solid forms of construction to ornamental and artistic finishes, cover a never ending supply of new thought and new creation. The strictly engineering side also appeals to me, road building, bridges, etc.

Concrete construction will become our staple and almost universal construction, as the building public will learn as the years roll by. Intelligent capitalists are, the clients most ready to adopt it, others will fall in line by the force of example. Our cement manufacturers are standing in their own light in this section of the country. Trade combinations hold the prices of cement too high. We look to the Panama Canal to relieve us, and I believe the time will come when we can abandon the lumber yard for the building of minor constructions as well as the major ones. It will become possible to make use of concrete in an extensive manner. You have my hearty sympathy and interest in your work of education in the construction of buildings and all kinds of engineering endeavor in concrete.

Structural Features of Sheet Piling Retaining Wall

A LETTER FROM WILBUR J. WATSON²

The retaining wall illustrated on p. 15 of the Jan., 1914, issue of CONCRETE-CEMENT AGE is subject to serious criticism. The illustrations do not show the spacing of the fly-

¹Sec., Henry S. Spackman Engrg. Co., Philadelphia

¹Arch., San Diego, Cal.

²Wilbur J. Watson & Co., Cleveland

ing buttress, but it appears to me that if this flying buttress were continuous it would not be of sufficient strength to withstand wave action. We have designed, and to a limited extent, have used a similar type of reinforced concrete sheet piling, but with a very thorough bracing, far different from that shown in this illustration.

The cap is also subject to criticism. It should be rectangular and the reinforcing rods should be placed near the outer edges. The principal criticism, however, is on the buttress. It would be interesting to know if this bulkhead has ever been subject, either to the pressure of a fill behind it or the pressure of waves beating up against it. The writer does not see how it can withstand either of these pressures.

A very effective way of heating sand on cold weather concrete work is to turn exhaust steam into the sand pile in some way. An effective device for doing this has been used on a new industrial building being erected in Detroit by the Selden-Breck Co., St. Louis.

The superintendent of this work, G. A. Harwick, used a 2-in. pipe 14' long with $\frac{1}{8}$ -in. holes drilled in the pipe 6" o. c. A $\frac{3}{4}$ -in. feed is tapped into this pipe about 4" from one end. A plug is screwed into the end where the steam goes in and the entire outfit can, with a sledge, be driven right into the sand pile, when necessary. Of course, the best way is to dump the material on top of the pipe, but this is not always possible. If a solid cone could be fitted on the front end of the pipe there is no doubt that the same outfit could be driven into a pile of crushed stone.

When machine shop equipment is not available, any size pipe could be perforated by sawing notches at any spacing with a hand hack-saw. These openings would serve the same purpose as drilled holes.

Salamanders are often very necessary in putting down top finish. To eliminate the trouble of having these in the way on the floor, some contractors suspend them from the ceiling so that they hang about 12 ins. above the floor.

Where a floor is built around machinery foundations, frequently a long span and a short span beam come close together. Unless provision is made for a joint between them, there is certain to be an unsightly crack, due to the difference of deflection of the two under the same load.

New Books

Reinforced Concrete Construction, Vol. II, Retaining Walls and Buildings—Prepared in the Extension Division of The Univ. of Wis., by George A. Hool, S. B., Assoc. Prof. of Struct. Engrg., McGraw-Hill Book Co., N. Y. C. and London. Cloth, 6" x 9", pp. xvii + 666, illust. \$5.00 net.

A little over a year ago the first volume of this series was published and a third is yet to appear, the subtitle of the first being "Fundamental Principles"; the third volume is to cover bridge design and construction, but its full scope has not been announced. The preface of the first volume stated that the book was designed "to meet the needs of those who desire to take up the study of the subject by correspondence." The author, however, saw "no reason why a text of this nature might not be employed for other purposes." In Vol. II the author has amended this by saying: "It has been prepared to meet the needs of students having varying qualifications, and on this account is more comprehensive in some respects than the ordinary textbook dealing with these subjects." A general knowledge of the principles of reinforced concrete design has been pre-supposed and detailed statements are not explained but are referred to the basic principles brought forward in the first volume of the series. The author, however, has succeeded in producing a work in which clarity of expression makes it unique among text-books for engineering instruction.

The first section of the book is devoted to retaining walls, three chapters with about 67 pages of text. Part II, on buildings, is divided into three sections, design, construction and estimating, with 24 chapters. There is an appendix containing the second report of the Joint Committee on Concrete and Reinforced Concrete and an index.

Prof. Hool gives the standard theory of the earth pressures on retaining walls as enunciated by Rankin, but puts forth an empirical method by which the equivalent fluid pressure acting upon a gravity wall and giving a resultant intersecting the outer edge of middle third of the base is determined, and then uses this basis for estimating the stresses in a reinforced concrete wall. The great diversity of practice which appears in retaining wall design il-

lustrates the fact that basic data and the assumptions made from them vary. Retaining wall failures are occasionally heard from and some walls stand which, according to all accepted principles, should fail. After the earth pressure has been obtained Prof. Hool reverts to standard methods of design. Several typical retaining wall sections are fully illustrated. There is very little to be found in the chapter on the construction of retaining walls and these two pages of text might without loss have been omitted or devoted to some other subject.

The section upon buildings starts off with the consideration of floor construction. Descriptions and drawings show the numerous methods used and worked out examples are given. The flat slab construction is analyzed; in this the author has not succeeding in preserving the clarity of expression found elsewhere in his work. However, he has succeeded as well as many others who have tried this subject.

The important subject of wearing surfaces on floors is dismissed in four pages, whereas its adequate treatment would require much more space. Loads are briefly considered and those suggested by several sources are given. A number of methods of attaching lingers for shafting and other purposes are detailed.

The chapter devoted to types of reinforcement gives a brief and correct description of the various fabrics. Some of the bar systems are shown but the "57 varieties" have been omitted without any loss to the user of the book. Waterproofing and drainage are taken up in the chapter on roofs and typical designs and details are given.

There is a general discussion of columns in chapter VII. The author favors the circular hooped column; the small value of vertical reinforcing, and its practical lack of value, except when restrained by hoops, might be more fully brought out. A number of typical foundations are illustrated in the next chapter. Plain footings, cantilever footings and raft foundations are shown in detail. The bearing value of soils is discussed. The illustrations in this section are particularly valuable and well selected to illustrate many of the neglected points of design. The section of this chapter devoted to concrete piling is

extremely short and could with advantage be extended.

The chapters, "Walls and Partitions" and "Stairs" are mainly made up of illustrations, which tell the story much better than many times that space devoted to text. The text, while brief, is to the point. The chapter "Elevator Shafts" includes considerable matter upon different types of elevators. The reason for including this in the book is difficult to fathom. The other half of the chapter is, however, very pertinent. Two and a half pages are devoted to "Provisions for Contraction and Expansion." The methods shown are excellent.

In "Shear and Moment Considerations in Continuous Beams" the highly theoretical considerations of design are discussed in detail. Prof. Hool has endeavored to avoid the use of calculus and for this reason his analysis may not meet the favor of those who are fond of ascending to those remote mathematical heights, but at the same time this presentation will lead many more to an understanding of this subject. "Eccentric Load Considerations in Columns" is treated with similar simplicity, the author having borrowed liberally from the work of Faber and Bowie, to whom he gives due credit. Five pages devoted to wind stresses do not permit much to be said, but what is said is clearly to the point.

The next two chapters, XVI and XVII, include the specifications and detail design of a factory building which was erected from the plans of a reinforced concrete designing concern. Very little was omitted from the plans and specifications when putting them in shape for use in this volume.

Chapter XVIII starts the section upon construction and contains general matter found in most books upon concrete design. The subject matter upon forms gives more drawings than are usually found in the works in which this subject is covered to any extent. Chapters XX to XXIII inclusive are similar to much that is in print, except that the "chute method" of handling concrete has been added to those methods which have been frequently and adequately described. These subjects, however, could not have been omitted without causing criticism, and it is a case of being hung if you do and hung if you don't.

The Chapter on "Construction Plant" is by A. W. Ransome, of the Ransome Concrete Machy. Co. Considerable valuable information is supplied in regard to the design of such a plant to suit working conditions.

Undoubtedly some will disagree with Mr. Ransome's time schedule for mixing, without considering that this means merely the interval between charging and discharging the mixed concrete, and that the mixer is usually revolving while receiving the charge and while discharging.

The section upon estimating was written by Leslie H. Allen, of the Abertshaw Const. Co.; a detailed estimate is given for the building whose plans and specifications were shown in Chapters XVII and XVIII. To many this section alone is worth the price of the book, as it exemplifies the estimating practice of a successful concern. The estimate given, however, is merely the net cost without any allowance for overhead and profit.

Possibly the most valuable feature of Prof. Hool's book is due to his extensive use of line cuts taken from practice which will make the book a valuable one to all of those who have to do with reinforced concrete construction.

A Building Ordinance For Small Towns and Villages—Published by the Natl. Bd. of Fire Underwriters and the Natl. Fire Protection Assn., N. Y. C. and Boston, 6½" x 4", cloth, 40 pp.

The work of Ira H. Woolson, cons. engr. of the Natl. Bd. of Fire Underwriters, is too well known to need any introduction here. This volume is a concise and definite presentation of what Mr. Woolson's work stands for now and has stood for in the past. This booklet might well be termed "First-Aid For Better Building."

This book, as it stands, is a concise presentation of a suggested ordinance providing for fire limits and the construction and equipment of buildings, especially in small towns. The book is an abbreviation of modern requirements, and presents briefly the best practice in building construction. It should serve as a reasonable regulation for ordinary building construction in communities where congestion of values is not abnormal. The authors call attention to the fact that this suggested ordinance is not a building code in the same sense that term is generally understood.

Directory of Cement, Gypsum and Lime Mfrs.—The Cement Era, Chicago, 5" x 3¼", leather, 214 pp.

This is the eighth annual edition of this valuable directory, which includes a complete list of the manufacturers of cement, gypsum and lime. The information given for

each individual plant includes the location of the office and works, the officers, capitalization, production and some brief notes on the principal equipment. The same information is given in regard to the gypsum and the lime companies. The lime companies are classified by states. The addition of a thumb-cut index for handy reference to the four lists makes the directory of greater value. A thinner paper used in this edition makes the book more compact and easier to handle.

Absurdity of Wood Reinforcement

An article was recently submitted for consideration presenting in detail a discussion of the possibilities of reinforcing concrete with wood. It seems that some enthusiastic engineer has carried out quite a few experiments along this line. Looking at the matter carefully, it does not seem that the proposition should be entertained seriously. Concrete once up is a very permanent material. Put up in the shape of beams or floor slabs, the steel reinforcing plays a vital factor in resisting the tensional stresses. To consider putting up concrete beams reinforced with strips of wood is an absurdity. The enthusiastic experimenter referred to had a good deal of trouble in getting the wood soaked to the proper condition before the concrete was placed around it. If the wood was too dry, it cracked the concrete; if it was too wet, there was no adhesion.

If anybody wants to reinforce concrete with wood he should make his concrete beams and nail wooden strips on the outside where they can be watched and replaced when necessary. Wooden strips, buried in concrete and acting to reinforce it, should not be considered seriously.

Don't Work in the Mud

The Selden-Breck Co., St. Louis, has just completed a magnificent building for a new Ford service station in Detroit. On this work G. A. Harwick, the superintendent, ran the basement floor as early in the work as possible. It was placed right after the foundation walls were completed. With this floor in place the whole basement is available as a storage place for materials, machinery, etc. It is much better than working in the mud.

A Report on Standardizing Tests and Testing Methods

A very able report analyzing and summarizing testing work on concrete materials was submitted at the recent convention of the American Concrete Institute by A. N. Talbot, of the Committee on Specifications and Methods of Tests, speaking for Sanford E. Thompson, *clmn.* The work of the committee in the past year has been chiefly the planning of tests of concrete to be carried on in various laboratories, and the compilation of the valuable results which are embodied in the following report:

Tests of aggregates require, in the first place, investigations of methods of making up test pieces of concrete.

The objects of these principal tests have been:

(1) To determine the size and shape of concrete test piece to recommend as a standard for tests of concrete in the laboratory and in the field, so as to obtain results as uniform and as comparable with actual conditions as practicable, and

(2) To determine the relative strength of concrete test pieces of different shape and size for comparison with the strength of test pieces of the standard shape.

In connection with these tests the series also included the effect of different consistencies in mixing upon the strength of concrete; the effect of varying the size of the coarse aggregate; the relative strengths at different ages and with different consistencies; and the effect upon the strength of different methods of storage of test pieces.

Besides these tests which are now being made, the committee has planned tests to determine the relative strength of concrete test pieces made in the laboratory and test pieces of similar concrete cut out of the actual structure; and tests to determine the effect upon the strength of concrete of sand of different fineness. A part of this new work has been given out this winter to different laboratories.

The committee also has under consideration:

The effect of different methods of storage upon the strength of test pieces.

Standard methods of capping compression test pieces preparatory to crushing.

Standard methods for making field test pieces.

Standard methods of determining weights of aggregate.

Standard sieves for analyzing sands and gravels.

Effect of chemical and mineralogical composition of the aggregate upon the strength of concrete.

CONCLUSIONS FROM TESTS OF CONCRETE

As a result of tests made in the various laboratories, the following conclusions have been reached:

(1) The best shape of test piece is a cylinder. A height of double the diameter presents advantages over other proportions. Tests of similar cylinders show slightly less variation from each other than tests of square prisms or cubes. Where the height is double the diameter, the effect upon the strength of slight inequalities in height of different test pieces is eliminated. This is shown in the curve in Fig. 1.

(2) Cubes, cylinders or prisms, not shorter in height than their least diameter, can be used for comparative tests.

For comparison with test pieces of standard shape, the strength of these may be corrected by a ratio.

(3) The smallest dimension of the test piece should be at least four times the size of the coarsest particles of stone.

(4) The shape of the test piece appreciably affects the strength.

(5) The strength of test pieces increases as the height decreases. Assuming a test piece whose height is double the width as a basis for comparison, a cube of the same mix will have about 37% greater strength and a test piece whose height is half its width, about 109% greater strength. As the length of the test piece becomes greater than twice the width, the strength decreases slightly. (See Fig. 1.)

(6) Tests of similar concrete made with different percentages of water tend to confirm conclusions previously established, that an increase in quantity of water in mixing reduces the strength of the concrete to a marked degree, and that this reduction is especially marked at the earlier ages. (See Figs. 2 and 3.)

(7) The growth in strength with age, using different consistencies of concrete, can be estimated. (See Fig. 2.)

The higher loads carried by test pieces which are shorter than $1\frac{1}{2}$ diameters are ordinarily attributed chiefly to the effect of the restraint against lateral swelling of the test pieces under load, which is developed by the friction between the bearing plates of the testing machine and the ends of the test piece.

Researches in literature and tests by individual members of the committee indicate that the strength of concrete of given proportions increases as the size of the coarse aggregate increases. In the present series the results on this point are inconclusive, although tending in this direction.

The size of the test piece appears to affect the strength to a certain degree, but because of varying results in different laboratories, no definite conclusion has been drawn.

The method of storing the test pieces

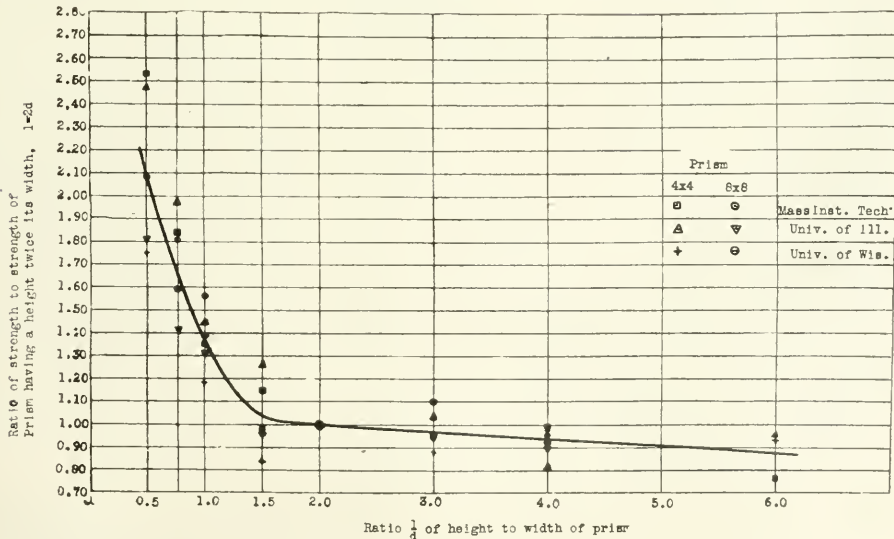


FIG. 1—COMPARATIVE STRENGTH OF CONCRETE PRISMS OF DIFFERENT HEIGHTS

has a marked influence upon the strength of the concrete. Further tests on this point are necessary before drawing definite conclusions as to relative strength under different conditions.

RECOMMENDATIONS

1. It is recommended tentatively that the shape of the standard concrete test piece be a cylinder having a length of twice the diameter. The diameter should not be less than 6" except with very fine stone, when 4" may be adopted. It appears advisable that the diameters of the cylinder should be at least four times the maximum size of the coarsest particles of the aggregate. The 8-in. x 16-in. cylinder, which has been adopted by the Joint Committee on Concrete and Reinforced Concrete is a satisfactory size when shipment of materials or other limiting condition does not preclude its use.

2. The strength of cubes or cylinders having a length equivalent to the diameter can be approximately converted to strength of cylinders of double the diameter by multiplying by 0.73.

3. For field tests of concrete in actual construction, concrete should be taken from the loose mass after it is dumped from the barrow or other receptacle and

before it is tamped or otherwise compacted.

4. The size of field test pieces should conform to the recommendations given above.

5. Field test pieces should be embedded completely in sand located near the site of the structure and the sand kept continuously moist until ready to ship to the laboratory. The test pieces for shipment should also be packed so as to retain their moisture.

SERIES OF TESTS

The following series of tests have been made and reported by the various laboratories:

Series 1. Comparative tests of concrete to determine the variation in strength due to the size of the test piece, using aggregates of different maximum size.

Series 2. Comparative tests to determine the variation in strength due to the height of test pieces 4" x 4".

Series 3. Comparative tests to determine the variation in strength due to the height of test pieces 8" x 8".

Series 4. Comparative tests of strength of cylinders versus cubes and prisms.

Series 5. Growth in strength of concrete using different consistencies.

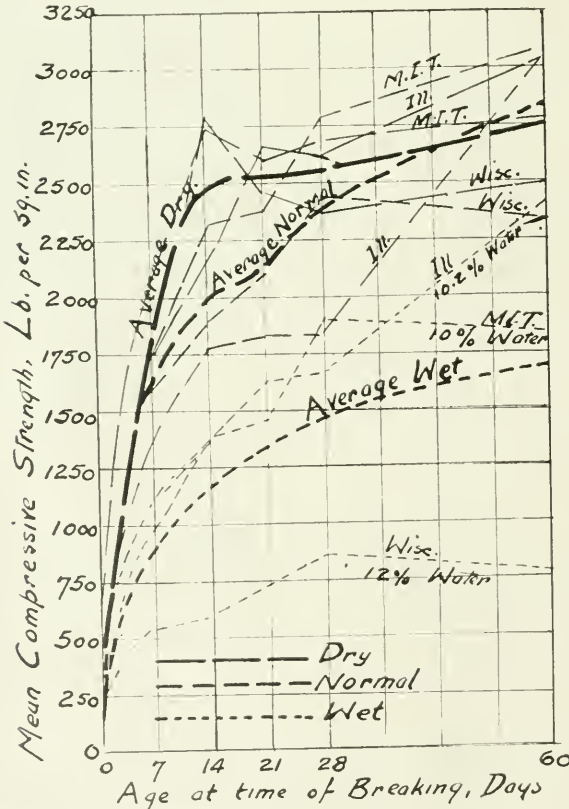


FIG. 2—GROWTH IN STRENGTH OF CONCRETE OF WET, NORMAL AND DRY CONSISTENCIES

Proportions about 1:2:4. Individual curves from each university and composite curves for each consistency. Specimens 6-in. x 6-in. cylinders. For approximate strength of 8-in. x 16-in. cylinders divide values by 1.37

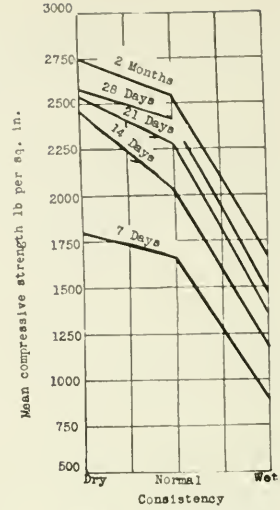


FIG. 3—COMPARATIVE STRENGTH OF CONCRETE OF DIFFERENT CONSISTENCIES AT DIFFERENT AGES

TEST FOR NORMAL CONSISTENCY

In one series of tests are included test pieces of different consistency. In most of the series what is termed "normal consistency" is adopted throughout. Because of the difference in the effect of different sands upon the consistency, it was impossible to specify a definite percentage of water. Tests made by members of the committee indicate that the most uniform degree of consistency can be obtained by adopting the Chapman¹ consistency test, which consists in filling a slightly tapering cylindrical form with concrete, immediately withdrawing the mold, and by repeated trials finding the amount of water which will cause the concrete to just begin to slump when the form is removed. A dry mix is of course unsatisfactory, while it is almost impossible to describe a very wet mix which will insure uniformity.

It is appreciated by the committee that the normal consistency selected is not nearly so wet as is ordinarily used in reinforced concrete construction. In actual construction, however, the concrete is machine-mixed, which tends to give a higher strength than hand-mixed concrete, but the difference would not be marked when the concrete is mixed by hand in very small quantities, as was the case in making these test pieces. Furthermore, incidental tests of pieces of concrete cut out from the interior of the concrete in actual structures, while not as yet by any means conclusive, tend to indicate a higher strength than can be obtained normally from individually molded test pieces.

In view of these considerations, a plastic consistency, such as is described above, may be tentatively adopted as a "normal consistency" for use in making test pieces.

STRENGTH VARIES WITH WEIGHT

Examination of the various tests shows that exceptionally low strength is coinci-

¹Described in CONCRETE-CEMENT AGE, July, 1913, p. 8

TABLE I—RELATIVE STRENGTH OF CONCRETE CYLINDERS OF DIFFERENT SIZES

Coarse aggregate $\frac{1}{2}$ " to $\frac{3}{4}$ ". Each value is an average of four test pieces. Normal consistency. Proportions about 1:2:4. Age 3 mos.

Cylinder		Average Breaking Strength, lb. per sq. in.			
Diameter, in.	Height, in.	Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.	Average.
4	4	3154	2570	2662	2795
6	6	3386	3200	3042	3209
8	8	3350	3140	3705	3308
10	10	3141	2890	3117	3019
12	12	3012	2965		2988

TABLE II—COMPARATIVE STRENGTH OF CONCRETE CUBES AND SQUARE PRISMS VS. CYLINDERS OF DIFFERENT SIZES

Each value is an average of four test pieces. Normal consistency. Proportions about 1:2:4. Age 3 mos.

Size, in.	Average Compressive Strength, lb. per sq. in.							
	Univ. of Ill.		Univ. of Wis.		Mass. Inst. Tech.		Average.	
	Prisms	Cylinders.	Prisms.	Cylinders.	Prisms.	Cylinders.	Prisms.	Cylinders
6 x 6	3711	3290	3010	2690	3575	3222	3432	3064
8 x 8	3521	3374	3135	2965	2917	3165	3524	3168
6 x 12	2547	2351	2245	2825	2440	2297	2411	2491
8 x 16	2759	2769	2260	2370	2496	2934	2505	2691

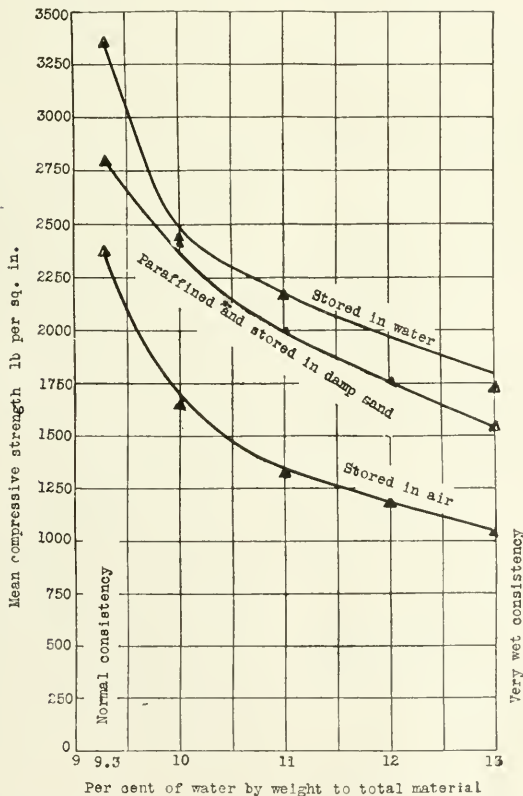


FIG. 4—EFFECT OF DIFFERENT PERCENTAGES OF WATER UPON THE STRENGTH OF CONCRETE WITH DIFFERENT METHODS OF STORAGE

Ages 3 mos. Proportions about 1:2:4. Each point is an average of five 6-in. cylinders. Tests at Univ. of Illinois

dent with exceptionally low weight per cu. ft. of the concrete. Previous tests made by members of the committee indicate that, eliminating other variables, the strength varies with the weight. In the present series, the exact dimensions of the test pieces were not always made, so that this point was not definitely verified.

EFFECT OF HEIGHT OF SPECIMEN UPON STRENGTH OF CONCRETE

To compare the strength of test pieces of different length, especially for comparing the strength of cubes or cylinders whose length is equal to the diameter with cylinders having a length double the diameter. Prisms 4" x 4" and another set 8" x 8" were made up of lengths varying from half the width up to six times the width.

It is generally recognized that the shorter the test pieces, the greater the compressive strength. A few tests have been made in the past of neat cement and others of sandstone prisms, but no comparative records of concrete test pieces of different height are on record.

Eliminating the variations due to local conditions, and presenting the results in a form suitable for direct use, a curve is presented in Fig. 1,¹ where the ratios of strength are shown, based on the strength of a prism whose length is double its width.

If the ratios are expressed in terms of a cube, it will be seen that a test piece half the height of a cube is 50% stronger than the cube, while a prism of double the height of a cube is about 73% as strong as the cube.

The variation in strength of test pieces of different height is due probably chiefly to the heads of the machine which confine the test piece. In actual construction, however, wherever the height is small in proportion to the width, there may be similar restraint.

EFFECT OF SIZE AND SHAPE OF TEST PIECE UPON STRENGTH

The relative strength of cylinders of different sizes is given in Table I. A comparison of cylinders with cubes or prisms is given in Table II. The cube or square prism is slightly stronger, about 4% on the average, than the cylinder whose diameter is equal to the side of the square. This may be due not so much to the variation in making the test piece as to the restraint of the heads of the machine.

EFFECT OF MAXIMUM SIZE OF AGGREGATE ON THE STRENGTH OF THE CONCRETE

The results of tests of concrete made up with the same sand but coarse aggregates of different size are inconclusive, because of the lack of agreement between laboratories. Two laboratories out of the three making these tests show an increase in the strength of the test piece with the increase in the size of coarse aggregate, and this is in line with the records of other tests. For 8-in. x 8-in. test pieces, and larger, the variation in strength of similar test pieces with either size of stone is about the same. For 6-in. x 6-in. test pieces, the finer stone gives as uniform test pieces as the larger dimensions. For the 2-in. stone, the 6-in. x 6-in. test pieces are less accurate, and for the 4-in. x 4-in. test pieces there is greater variation for all sizes of aggregate.

¹Results from the Univ. of California came too late to include, but agree in a general way with the curve

TABLE III—COMPARATIVE STRENGTH OF CONCRETE OF VARIOUS CONSISTENCIES AT DIFFERENT AGES

Each value is an average of four 6-in. cylinders. Proportions about 1:2:4. To convert strength to basis of 8-in. x 16-in. cylinders divide value by 1.37

Age.	Average Compressive Strength, lb. per sq. in.											
	Univ. of Ill.			Univ. of Wis.			Mass. Inst. Tech.			Univ. of Cal.*		
	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet
7 days	1751	1390	1103	1690	1580	533	2047	1740	965	1083	724	521
14 days	2140	1775	1354	2795	1906	600	2742	2320	1372	1802	805	676
21 days	2658	1816	1623	2450	2095	722	2594	2396	1464	2182	1093	834
28 days	2615	1820	1657	2380	2430	860	2679	2882	1895	2413	1225	909
2 mo.	3056	3063	2410	2485	2340	787	2761	3092	1830	2639	1560	1157
6 mo.	3941	3431	3281	3375	3860	1451	....	....	....	3485	2145	1304

TABLE IV—COMPARATIVE STRENGTH OF CONCRETE AT DIFFERENT AGES AND CONSISTENCIES STORED UNDER DIFFERENT CONDITIONS

Each value is an average of four 6-in. cylinders. Proportions 1:2:4 by weight. Normal consistency. Tests at Univ. of Illinois. Made from dry stone; for all other test pieces the stone had been thoroughly wet before mixing

Consistency.	Water in Mixing, per cent.	Storage.	Compressive Strength at Different Ages, lb. per sq. in.				
			7 days.	14 days.	21 days.	28 days.	2 months.
Dry....	8.4	Damp sand.....	1751	2140	2658	2615	3056
Normal	9.3	Damp sand.....	1390	1775	1816	1820	3063
Wet....	10.2	Damp sand.....	1103	1354	1623	1657	2410
Normal	9.3	Air.....	1481	2061	2126	2116	2232
Normal	9.3	Coated with paraffine	....	....	....	2314	2521
Normal	9.3	Damp sand.....	....	....	....	....	2734
Normal	9.3	Damp sand*.....	....	....	....	....	2208
Normal	9.3	Air*.....	....	....	....	....	....

TABLE V—COMPARATIVE STRENGTH OF CONCRETE WITH FORMS REMOVED AT DIFFERENT PERIODS

Each value is an average of five 6-in. cylinders. Proportions about 1:2:4 by weight. Normal consistency. Tops and bottoms of specimens paraffined after making. Age 3 mos. Tests at Univ. of Illinois

Treatment of Ends of Test Piece.	Forms and Paraffine Removed at Age of	Storage after Forms Removed.	Compressive Strength at Age of 3 months, lb. per sq. in.
No paraffine	1 day	Air.....	1978
Paraffine	7 days	Air.....	2343
Paraffine	30 days	Air.....	3166
Paraffine	90 days	Tested damp	3806

TABLE VI—RELATIVE STRENGTH OF CONCRETE PRISMS OF DIFFERENT HEIGHT

Each value is an average of 4 test pieces; normal consistency concrete, mixed about 1:2:4; age 3 mos. This data is plotted in Fig. 1

Ratio of Height to Width.	Average Ratio of Strength.	Height of Prism, in.	Prisms 4 in. Square.			Prisms 8 in. Square.		
			Average Compressive Strength, lb. per sq. in.			Average Compressive Strength, lb. per sq. in.		
			Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.	Univ. of Ill.	Univ. of Wis.	Mass. Inst. Tech.
0.5	2.09	2	6485	4320	5046	4	5409	4730
0.75	1.66	3	5170	3245	3672	6	4192	3596
1.0	1.38	4	3811	2915	2688	8	3898	3143
1.5	1.04	6	3306	2075	2288	12	2948	2260
2.0	1.00	8	2623	2265	1993	16	2981	2263
3.0	0.97	12	2732	2175	1910	24	2818	2146
4.0	0.94	16	2137	2423	1976	32	2689	2145
6.0	0.88	24	2513	2305	1853	....	....	....

* Ratio based on strength of prisms having height twice the width, $l=2d$.

GROWTH IN STRENGTH OF CONCRETE

The growth in strength of concrete for ages ranging from 7 das. to 2 mos. is given in Table III, for test pieces of different consistency. The results are shown graphically in Fig. 2.

EFFECT OF CONSISTENCY UPON THE STRENGTH OF CONCRETE

The results of test pieces made with different percentages of water correspond to results of other tests on record. The tests show lower strength as the percent-

age of water is increased. The strengths obtained by the different colleges are shown in Table III. In Fig. 2 the results are plotted, and to compare the consistency still better, Fig. 3 gives the curves arranged in the other way.

STORAGE OF TEST PIECES

The Univ. of Illinois stored the test pieces for its regular tests in damp sand. To compare the effect of different methods of storage, test pieces were placed in damp sand, air, water, and in damp sand after having been coated with paraffin. Table IV gives a comparison of the results for different consistencies and at different ages.

Table V presents a short series showing the effect of retaining the moisture in the test pieces for different periods by keeping the test pieces in the form for different lengths of time, while the heads are coated with paraffin.

Curves are shown in Fig. 4 giving the comparative effect of different methods of storage on concrete made with different percentages of water.

TESTS OF BEAMS OF PLAIN CONCRETE

The Univ. of Illinois made up 10 plain concrete beams 6" x 8" in section for transverse tests. The proportions were the same that were used in all the rest of the test pieces.

The beams were loaded at the one-third point of a 3-ft. span, the 8-in. dimension being vertical. The modulus of rupture at the age of 3 mos. varied from 684 lbs. to 844 lbs. per sq. in., with an average of 775 lbs. per sq. in.

NEED OF SPECIAL INVESTIGATION OF SAND

Properly to carry on an investigation of sand which cannot be satisfactorily handled by scattered laboratories, there is need of a special investigator who can take up the problem in a thorough and scientific manner. Nearly every day cases are brought to notice of defective and inferior concrete, made from sand good in appearance but containing certain almost invisible deleterious material which prevents the proper hardening of the concrete. Only by a carefully thought out and extended series of tests, both chemical and physical, of natural sands of good and bad quality, can the problems of the selection of sand for mortar and concrete be solved. There also should be found means for treatment of sands of poor quality to make it possible to use them under certain conditions. These questions are as important as any confronting the art of concrete and reinforced concrete construction.

Testing Laboratories and Concrete Development

Merrily the wheels of progress roll along in the testing of cement. Hardly a day passes that papers do not bring reports of the equipment of some new laboratory, municipal, state or governmental, for testing this important material of construction. The more cement is tested, the more uniform and permanent is it found to be, and cement manufacturers must welcome the equipment and installation of all these new laboratories in all parts of the country for the proper testing and inspection of their material. Portland cement indeed is the beast of burden of all large construction work.

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa.

American Highway Association, J. E. Pennybacker, Jr., Secretary, Colorado Building, Washington, D. C.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co.,

72 West Adams St., Chicago, Ill.; J. P. Beck, Sec.

Interstate Cement Tile Manufacturers' Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. P. Beck, 72 W. Adams St., Sec.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

described in detail, not as exhibits at the Cement Show, but as valuable and interesting additions to the construction field.

Such a Show brings home to the visitors the fact that concrete is an attractive, a practical, safe and economical material for building purposes. To men in concrete work such a show demonstrates the necessity of keeping in touch with the newest and best in concrete development. Cement shows, to everyone concerned, are well worth while.

In order to demonstrate the value of practical maintenance of highways, the American Highway Association has arranged, in co-operation with the Federal Office of Public Roads, and road officials in Virginia, North Carolina, South Carolina and Georgia, for an ambitious maintenance experiment on the road from Washington to Atlanta, Ga. More than 700 miles of road are expected to be improved and kept in condition as a result of the initiative of the American Highway Association. The experiment is on a larger scale than any maintenance experiment ever undertaken in this country. The Association will enlist the support of the counties and districts traversed by the road, and, wherever possible, induce the local authorities to place the road under the supervision of government engineers who will be detailed from the Office of Public Roads for that purpose under the co-operative arrangement.

The Assn. of Am. Portland Cement Mfrs. is doing good work in its crusade for good concrete roads. Hardly a day passes without some attention being called to the presence of lecturers from the association office in Philadelphia talking to engineering bodies, road congresses, citizens' meetings, college class rooms and college societies upon the vital question of better roads. The distribution of the valuable information gathered by the Association in the shape of plans, specifications, photographs, etc., by an efficient force, has contributed much to the development of the American standard highway, the Concrete Road.

William A. McCall, late manager of the *Dealers Building Material Record and Rock Products*, died in Chicago Sunday, Feb. 22. Mr. McCall as a trade paper man was a prominent figure in the building material field. His loss will be keenly felt by dealers in that field and by his associates among publishers.

Notes on the Chicago Cement Show

In considering the 1914 Chicago Cement Show as a whole, perhaps the most interesting feature, the point having the closest relation to the development of construction methods, and indicating the trend in construction methods, was the great number of small batch mixers exhibited. These small mixers were of two general types, the standard rotary drum, non-tilting type, and the open drum, tilting type. Models of each type were equipped with side loaders. This development of small batch mixers indicates that a light portable mixing unit must offer certain economies and a certain efficiency over either hand mixing or a larger mixing unit. Mixing efficiency is an interesting problem. The small batch mixer has had a surprising development; the definite relation between the two will probably be shown in more extended experience.

One of the most telling exhibits was the cement sack "mortality chapel." Around three sides of a booth were arranged 1½ small gray coffins—lined with black plush, well lighted and covered with glass. Each contained a damaged cement sack. The epitaphs were self-explanatory and, incidentally, amusing. Humanizing cement sacks is a novel thing, but what other effect could there be when we saw a poor, stained, torn, deformed cement sack lying in a plush casket, and read the "headstone":

Poisoned by An Overdose of
Mortar Color

Another one, over a gashed sack was:

Stabbed to the Heart by a Cruel Workman,
Who Took by Force What the
Sack Would Have Been Glad
to Give

The exhibits showed sacks which had been sewed up by amateur surgeons who did not understand sack anatomy and sewed up a "vital valve." Sacks ruined by rain and wet concrete, killed by carelessness, were shown. All in all, it was a very effective exhibit.

Drag-line excavator buckets, two-speed hoists, the latest developments in centering methods, in silo construction, in sidewalk work and miscellaneous equipment were shown. Block and tile machines, automatic tampers and architectural molds were in evidence. Many lines of building needs, artificial marble, floor lights, plaster board, etc., formed interesting exhibits.

An auto-traction continuous mixer attracted attention. Sidewalk and curb forms, expansion joints, gasoline engines, saw-tables, hand and power hoists, reinforcing steel, waterproofing materials, sack balers and belting exhibits interested the general contractor. Burial vaults and the molds for making them were on display. For the man interested in concrete on the farm, the models of the farm buildings and the exhibit of cattle stanchions were of interest.

Elsewhere in this issue, the Chicago Cement Show, just passed, is commented on editorially. In the New Equipment department of this and subsequent issues, some of the interesting developments in materials, methods and equipment will be

(Road Conference, Continued from page 124)

6—Methods and Costs of Repair and Maintenance

The report of the committee on repairing and maintaining concrete roads was presented in three parts. That part presented by the chairman, Edward N. Hines, chairman of the Bd. of Co. Road Commrs., Wayne Co., Mich., was fully covered in the Feb., 1914, issue, from data supplied from the county records.

J. S. McCullough, city engr., Fond du Lac, Wis., presented his portion of the committee report as follows:

FOND DU LAC, WIS.

The repairs on our pavements to the present time have been taken care of entirely by contractors who built the pavements, and are part of their obligation, under our contract. The pavements are guaranteed for five years, and our oldest work was five years old this past summer.

The methods of repairing cracks is similar to that in use in Wayne county. Both asphalt and Tarmac have been used, but we find Tarmac gives the better results.

We have had some work of replacing pavement cut out for installing service pipes, such as sewers, gas, and water, also a long piece for installation of telephone conduit. The telephone work was done by contract by the telephone company; all other repair of such excavations has been done by the city through its repair gang.

The excavation is made by the public utility after receiving permit from the Board of Public Works. Excavation is required to be back-filled with gravel, sand or crushed stone to sub-grade the pavement. Our men then proceed to trim the edges of hole so that the walls of the cut are as nearly perpendicular as possible. The edges of the cut are treated with a solution of muriatic acid which is washed off with clear water. Mixture same as original pavement is then put in and finished same as original work. Traffic is kept off until concrete is hard. Where the work has been carefully done we have had good success in making such patches. The cost will not exceed that of replacing brick that are cement grouted and, in fact, what records we have would indicate that concrete pavement patches can be replaced cheaper than the brick.

F. P. Wilson, city engr., Mason City, Ia., presented a further portion of the report in emphasizing the importance of certain features of the original construction as affecting the conditions of subsequent repair and maintenance.

7—Shoulders for Concrete Roads

The committee on Shoulders for Concrete Roads was composed of: Chairman, Maj. W. W. Crosby, Baltimore; E. A. Kingsley, state highway engr., Little Rock, Ark.; John H. Mullen, secy., Minnesota Road-makers Assn., St. Paul. Mr. Mullen

presented the report which in part of follows:

With the almost universal tendency in concrete road construction to keep the width of the concrete as low as practicable, in order to reduce the first cost (per mile) of the improvement of a road, has come, in many cases at least, a neglect of proper consideration of the matter of shoulders. In many cases the neglect referred to has unquestionably resulted in extravagance and waste in the long run, even if it has secured economy in first cost.

While authenticated records covering reasonable periods and concerning the relative expense for the proper maintenance of road-crusts and of shoulders respectively are not readily available, certain instances of such records (as published concerning Park Heights Ave., near Baltimore, Md.),¹ together with the individual experiences related by many authorities, tend to show that the shoulder maintenance costs may be no inconsiderable part of the total maintenance costs of a modern road, and that it may often be real economy to build the road-crust wider in order to reduce this annual expense for maintaining the shoulders and thus the total maintenance cost per sq. yd. From the Park Heights Ave. records above referred to it may be seen that, although the travel over the 24-ft. wide sections was four times that over the 12-ft. and 14-ft. sections, the cost of maintenance per sq. yd. of the road-crusts of the latter was more than twice that of the crusts on the wider sections, and the cost of maintenance of the shoulders on the narrower sections was nearly three times that for the shoulders along the wider crusts. Indeed the economy in maintenance on both the shoulders and road-crusts of the wider sections indicates that, in a 10-yr. period from the date of construction, real economy would have been had by increasing the width of the road-crusts so that nowhere would the latter have been less than 18' wide.

The actual width of the concrete roadway to be built must be determined by the traffic conditions to be expected on the road, and if these are sufficiently heavy to warrant so doing, it will probably be economical often to make the concrete itself wide enough to permit the passing of two lines of traffic wholly on its surface and without any necessity for either of passing vehicles to travel off the concrete onto the shoulder. On the other hand, traffic and other conditions may be such as to permit the greatest economy to be had by making the concrete only wide enough for one line of traffic and allowing the occasionally passing vehicle to travel on the shoulder for the moment.

The immediate vicinity of the line of contact between the edge of the concrete and the shoulder material will be found to be the tender region of both the road-crust and of the shoulder. The high rigidity of the concrete road and consequently the greater contrast between such a road-crust and other material usually available for shoulders increase the importance of careful consideration in the matter.

Where the concrete road-crust is so narrow that vehicles are almost constantly, in avoiding others, passing from the concrete to the shoulder, serious wear of both the road-crust and the shoulder will be found to take place along the region

of contact referred to, and this wear is frequently accompanied by the formation of a rut in the shoulder, which holds water in wet weather and thus endangers the foundation of the road. Some of the passing traffic will undoubtedly turn out onto the shoulder further than the rut, but at the extreme outside of the shoulder the travel over it may be so light and infrequent that the natural material there is not strained beyond what might be called "its elastic limit," and there then is no reason, on this account at least, for its replacement at any extra cost.

It will therefore be seen that the selection of the material and methods for the construction of shoulders for a concrete road requires the use of something between the natural soil, at the outside extremes, and the concrete itself; that the choices are determined by local conditions, such as availability of different materials and methods, width of the concrete road-crust, amount of traffic, etc., etc.; and that the wearing abilities or "elastic limit" of the shoulder material at any point should be outside or above the stresses to be expected at that point.

The passage of traffic from the pavement to soft adjacent material can of course be absolutely prevented, and the protection of the edges of the pavement be had by the installation of a raised edging or curb, as in the cases of most streets. The necessary reinforcement of the shoulder where no raised curb is to prevent traffic on it may be had in various ways. One would, of course, be to widen the concrete road-crust to such an extent as to preclude any possibility of traffic going off it. In doing this the center thickness of the crust need not necessarily be preserved to its edges but the thickness may be tapered down somewhat at the outsides. Or this widening (and tapering down in thickness) of the road-crust may be done over a portion of what might otherwise be the shoulder and then the reinforcement continued by the use of macadam or pit-gravel or other materials as may be necessary. Again, the width of the concrete road-crust being fixed, the shoulder reinforcement may be had by the construction of pitch concrete, pitch macadam, water-bound macadam (with or without a pitch carpet), etc., etc., adjoining the concrete road, all as may be necessary and desirable under the local conditions. The actual determination must be left to competent parties who will give due consideration to the local conditions and the principles referred to above.

8—Bituminous Surfaces for Concrete Roads

The Committee on Bituminous Surfaces for Concrete Roads was composed of: Chairman, E. J. Mehren, editor, *Engineering Record*, N. Y. C.; Henry G. Shirley, chief engr., Maryland State Roads Commission, Baltimore; Jas. R. Marker, Ohio state highway comr., Columbus. The report, in completed form, was presented by Mr. Mehren, who pointed out that usually the demand for a bituminous coating implies a lack of confidence in the concrete. The report was of a general nature. It was pointed out that tar had been found

¹Proc. Am. Soc. C. E., Vol. XXXIX, No. 7, p. 1706, etc.

more suitable than asphalt for coatings but that asphalt had given good results. The general trend of the report was that the use of bituminous surface treatments had not yet reached a point where standard practice could be recommended. It was indicated as one thing upon which the committee was certain that concrete pavement should be laid with as much care in every case as though it were not to have a surface of bituminous material.

In the discussion, E. S. Larned, Boston, suggested an air-blast as a means of cleaning the concrete surface before applying the bitumen. He also mentioned the use of water, suggesting a thorough flushing of the surface and then enough time permitted partially to dry the concrete. He said the concrete should contain some moisture but water should not show on the surface when the bitumen is applied.

Mr. Tunnichiff gave it as his experience that tar sticks best on dryer work, at least he found better adherence when the concrete was four weeks old than when it was 10 days old. In connection with this moist surface condition it was given as the opinion of another speaker that asphalt will adhere under such conditions and tar will not.

Mr. Hewitt, Jefferson, Ill., brought up the matter of laitance and its effect upon adherence of bituminous coatings. It developed later that it is common for the bituminous mat to peel and take with it a layer of laitance, indicating in such cases at least that the lack of bond is not so much between the bitumen and the concrete as between the concrete proper and the quite lifeless film of laitance.

9—Finishing and Curing Concrete Road Surfaces

The Committee on Finishing and Curing Concrete Road Surfaces was composed of: Chairman, F. E. Turneure, dean Coll. of engrg., Univ. of Wisconsin, Madison; H. J. Kuelling, pres., Wisconsin Highway Commissioners Assn.; E. B. Boyer, engr., Atlas Portland Cement Co., N. Y. C. Prof. Turneure presented the report, which is not at this time in completed form, recommending a uniform surface because it wears best; homogeneity of material, because this is necessary for good results in finishing. The report recommended finishing with a wood float, working from a bridge and did not favor a broomed surface because a short period of wear obliterated the

markings and left just that much less concrete to wear. The report urged the importance of sufficient moisture in curing, pointing out that a soft surface due to improper curing is more porous and therefore more liable to frost action. The report recommended that the pavement be kept wet for at least seven days, and pointed out that one sprinkling a day is not enough when it is considered that evaporation may be as great as $1\frac{1}{4}$ " in 24 hours.

It was suggested in the discussion which followed that a broomed surface exposes larger areas to the air and dries out rapidly so that the subsequent wear on the ridges is very rapid. It was also suggested that brooming usually is done after initial set takes place, so that the surface is seriously injured.

An important suggestion was made by Godfrey Smith, engineer of the Newport News (Va.) Drydock & Shipbuilding Co., with reference to steam curing in concrete road work. He said that at a future time he would make a detailed statement of his experience. After the session, however, he explained in conversation, that in building a few hundred feet of concrete roadway where it was very important that the thoroughfare be closed to traffic as brief a time as possible, he used steam applied through perforated pipes under canvas stretched over the concrete. Mr. Smith said that he was able to get a condition of hardness in the concrete in 48 hours which equaled concrete after 10 days or two weeks under ordinary conditions.

THE "DIKING METHOD"

Another important suggestion as to methods in curing developed in the account by H. P. Gillette of practice in concrete road work in California. Instead of sprinkling several times a day as would be necessary in a very dry, warm climate, earth is piled up at the sides of the road, forming dikes. The concrete is then flooded to a depth of about 2", which gives enough water to insure proper curing. This method obviates the labor of frequent sprinkling and the labor of cleaning the concrete of earth, which in most places is put on to keep the concrete from drying too rapidly.

10—Economical Handling and Hauling of Materials

The Committee on Economic Methods of Handling and Hauling Materials for Concrete Roads was composed of: Chairman, Halbert P.

Gillette, editor, *Engineering and Contracting*, Chicago; Donald D. Price, state engr., Lincoln, Nebr.; Percy H. Wilson, secy., Assn. of Am. Portland Cement Mfrs., Philadelphia. The report will appear in a later issue.

11—Mixing and Placing Materials for Concrete Roads

The Committee on Mixing and Placing Materials for Concrete Roads was composed of: Chairman, Paul D. Sargent, chief engr., State Highway Commission, Augusta, Me.; Arthur H. Blanchard, prof. of Highway Engrg., Columbia Univ., N. Y. C.; C. W. Boynton, insp. engr., Universal Portland Cement Co., Chicago. Mr. Boynton read the report, which will be presented in a later issue.

12—Cost of Constructing Concrete Roads

The Committee on Cost of Constructing Concrete Roads was composed of: Chairman, A. N. Johnson, state highway engr., Springfield, Ill.; Joseph Hyde Pratt, state engr., Chapel Hill, N. C.; Albert Reichmann, pres., Western Society of Engineers, Chicago. The report, presented by Mr. Johnson, follows:

Your Committee made an attempt to secure at first hand cost data in various parts of the country where concrete road construction has been done.

Although numerous inquiries were sent out by your Committee for information, there has not been received as yet any large amount of cost data except from the Michigan State Department, Wayne County, and the Illinois Highway Department.

There has already been issued by the Assn. of Am. Portland Cement Mfrs. a very complete table of cost data, and your committee decided that until more complete data were in its hands it would be but a mere duplication to publish what had already been issued.

The committee has therefore confined itself to averaging the cost of work reported in the different states, confining the comparison to the one course construction.

These data are presented herewith in the following table:

AVERAGE COST OF ONE COURSE CONCRETE ROADS	
State	Cost Per Sq. Yd.
Arizona	\$1.20
Arkansas	.90
California	1.17
Colorado	1.25
Connecticut	1.32
Delaware	1.61
Idaho	1.09
Illinois	1.01
Indiana	1.23
Iowa	1.11
Kansas	1.08
Maine	1.48
Maryland	1.21
Massachusetts	1.29
Michigan	1.27

Minnesota	1.05
Missouri	1.17
Montana	1.85
Nebraska	1.40
New Jersey	1.12
New York	....
North Dakota	1.26
Ohio	1.22
Oklahoma	1.05
Oregon	1.39
Pennsylvania	1.16
Tennessee	1.20
Washington	1.81
West Virginia	1.82
Wisconsin	1.06
Average Total	\$1.24
Weighted Total Av.	\$1.19

There are also presented four diagrams: Fig. 1 showing the distribution of cost data on concrete roads built 1909-1912, as reported by the State Highway Department of Michigan. Fig. 2 is a similar diagram compiled from cost data reported on the concrete road work done in Wayne County, Mich., in 1912 and 1913. Fig. 3 is a similar diagram for the work done in 1912-1913 by the Illinois Highway Commission. Fig. 4 is the average of all the data from which the first three diagrams were made, taking due account of the relative amount of work done in each instance.

In general, it is to be noted that the labor cost is about 44% while the materials cost is about 56%; and that the cement cost is a little over one-fifth of the total cost of the road, while the aggregate cost is a little over one-fourth of the total cost.

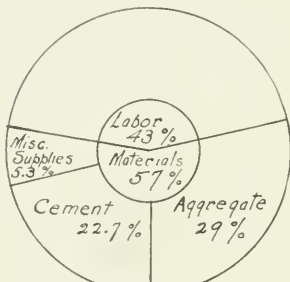


FIG. 1

Concrete Roads Cost Data on Seven Michigan Roads Built 1909-12. From a report by Commr. Frank F. Rogers of Michigan. Average cost per sq. yd. (excluding excavation), \$1.62

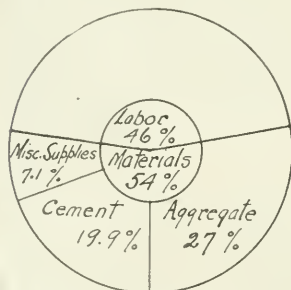


FIG. 2

Concrete Cost Data on Eight Sections in Wayne Co., Mich. Constructed 1912-13. Average cost per sq. yd., not reported

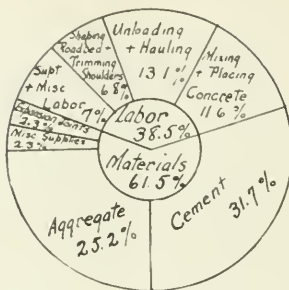


FIG. 3

Concrete Roads Cost Data, Covering Construction Through 1913, by Illinois Highway Commission. Average cost per sq. yd. (excluding excavation), \$9.93

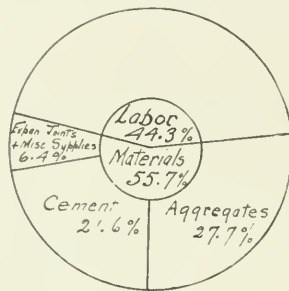


FIG. 4

Concrete Roads Cost Data: An Adjusted Average Covering Data from Seven Michigan Roads, Eight Wayne Co., Mich. Roads, and 1912-13 Work by Illinois Highway Commission

13—Thickness, Crown and Grades for Concrete Roads

The Committee on Thickness, Crown and Grades for Concrete Roads was composed of: Chairman, Leonard C. Smith, In Charge of Roads and Pavements, Univ. of Wisconsin. Madison; Earle R. Whitmore, city engr., Port Huron, Mich.; T. R. Agg, asst. prof. in civil engineering, Iowa State College, Ames. The report in part follows:

14—Proportion and Consistency of Materials

The Committee on Proportion and Consistency of Materials for Concrete Roads was composed of: Chairman, C. U. Boley, city engr., Sheboygan, Wis.; C. C. Widener, city engr., Bozeman, Mont.; George A. Dingman, engr., Board of County Road Commissioners, Wayne County, Mich. The report follows:

Any specification for proportion and consistency of materials for concrete pavement must be general and sugges-

tive, rather than mandatory, adaptive, not rigid. The representatives at this conference come from all parts of the country, from districts whose geological formations furnish concrete materials differing widely in their physical and chemical composition and also furnish soils of equally wide characteristics upon which these pavements are to be laid.

Ideal paving concrete is a combination of perfect mineral aggregates and cement in such proportion as will give the greatest possible density, and in which, for economical considerations, the cement content is the least possible, consistent with ultimate strength and durability. Relative cost of material may justify greater thickness of base with less crushing or tensile strength per unit area.

TWO-COURSE PAVEMENT

Base Proportions—For sound hard limestone or gravel having 40% voids, screened washed bank sand having 30% voids and Portland cement, passing the standard specifications of the Am. Soc. for Test. Mat., the proportions should be 1 sack of cement, 2½ cu. ft. of sand and 5 cu. ft. of crushed stone or gravel, the aggregate having been so proportioned as to eliminate the voids as far as practicable.

Consistency—The amount of water should be such as to make the concrete plastic and still retain its shape, such as is commonly called a quaking mixture. Methods and distance of transportation before depositing will be factors in determining the amount of water used; concrete deposited from buckets, traveling along a boom, may have more water added than when wheeled for a considerable distance in barrows or carts. In the latter case the unavoidable shaking brings the lighter materials to the surface and causes a segregation of the materials, which results in an improper mixture when deposited.

WEARING COURSE

Proportions—The fine aggregate for wearing course shall be mixed with Portland cement in the proportion of 1 sack of cement to 2 cu. ft. of the graded mineral aggregate. While this furnishes a considerable excess of cement we get greater impermeability.

Consistency—Sufficient water shall be used with the fine aggregate to form a mortar that will work easily under the template and at the same time retain its shape when deposited.

The report was made by Mr. Boley, who said that in Sheboygan two-course pavement varied in cost between \$1.20 a sq. yd. in 1911 when cement was cheap to \$1.35 for later work. This is for work 8½" thick at the center and 6½" at sides on a 30-ft. street with a crown of 3" to 4".

15—Form of Specifications for Concrete Roads

The Committee on Form of Specifications for Concrete Roads was composed of: Chairman, A. Marston, dean and director, Division of Engineering, Iowa State College, Ames; A. N. Talbot, pres., Am. Soc. for Test. Mat., Urbana, Ill.; George W. Cooley, state engr., St. Paul. Professor Talbot presented a report outlining a form of specifications.

New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

A One-Piece Flexible Column Clamp

A column clamp possessing rather unusual features has recently been put on the market by the Sterling Wheelbarrow Co., Milwaukee, Wis. The essential features of this clamp are a locking hand lever clamp, a swinging arm to hold this locked and a strip of band iron.

In the accompanying sketch *a* represents the malleable iron hand lever; *b* is the clamping head which is riv-

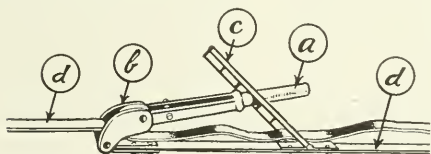


FIG. 1—DETAIL SKETCH SHOWING ARRANGEMENT OF DIFFERENT PARTS OF BAND COLUMN CLAMP

eted to and pivots upon the hand lever; *c* represents the locking device attached to the band iron about 11" from the clamp head. This can be easily swung back and forth. *d* represents the strip of band iron. This is usually of No. 16-ga. 11½" wide and 14" long.

In operation the band is passed around the column form to be held and the end is passed through the clamp head as shown in Fig. 2. When the iron is passed through the

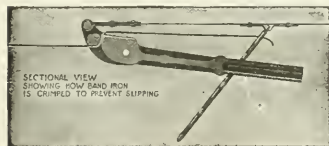


FIG. 2—DETAIL VIEW OF CLAMPING HEAD
March, 1914



FIG. 3—THE CLAMP BEING PLACED AROUND A COLUMN

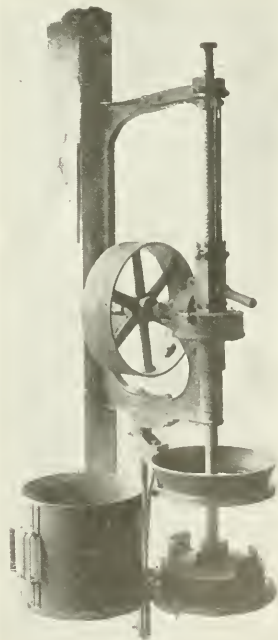
head the lever arm, *a*, is pushed way forward, making a free passageway between the clamp head and the point of the arm. The band is then tightened by ratcheting the lever several times, holding the free end of the band taut. This ratcheting grips and releases the band, drawing it tight no matter how "kinked" the band was before being put around the form. When the band is sufficiently tight the lever arm is swung down to the position shown in Figs. 1 and 2, and held in place by swinging the locking arm over the head.

When forms are being removed the only operation necessary is to release the lever arm *a* from the locking device *c* which releases the band iron. Where extra leverage is required an extension handle for the hand lever gives a greater leverage. This is so arranged that it can be locked.

The Williams Patent Crusher & Pulverizer Co. announces the removal of its general sales dept. to more commodious quarters, suite 1585-1588, Old Colony Bldg., Chicago, Jan. 15, 1914.

A New Power Tile Machine

The accompanying illustration shows a power concrete tile machine very simple in construction. It will make tile in 4-in., 5-in., 6-in., 10-in. and 12-in. sizes, and while the manufacturers make no definite claim for its output per day, they do say that in spite of its very simple construction and few parts it will make tile as rapidly as many larger and more complicated machines, the exact out-



ACME POWER TILE MACHINE

put being dependent upon the means provided for feeding in the concrete and taking away the tile. The machine is made by the Acme Tile Machine Co., La Grange, Ind., which calls special attention to the fact that while the illustration makes the machine look small, it is the simplicity and the few parts which give this effect. The frame of the machine is cast in one solid piece, and there are no small parts. The packer shaft is 1 7/16" in diameter, has a 10-in. bearing and is held perfectly in line. The shaft is raised and lowered by heavy threads on the shaft operated by split nuts which are securely locked when engaged with the thread. It is not an automatic machine but is entirely under the control of the operator. A hand machine manufactured by the same company is of a similar design.

A New Garbage Receptacle

The possibility for a new line of work for concrete products manufacturers is suggested in the Norristone sanitary garbage receptacle, which has been in use for some time in Rochester, N. Y. The receptacle is sunk in the ground with the top projecting from 1" to 4" as may be desired. The body of the receptacle is made of reinforced concrete of dense, impervious quality. An iron rim, with an inside flange for holding a galvanized garbage pail, is embedded in the concrete and is held in place by lag screws cast into the concrete. Hinged to the iron rim is a lid covering the top of the receptacle and projecting sufficiently to prevent rain getting into the garbage. In the lid is a round opening covered by twin lids which are so constructed as to be swung open by a motion of the foot, for depositing garbage, and to close automatically when released.

The whole combination is simple and should prove durable and secure against the invasion of cats and dogs. It is not an invitation to flies and other insects. Being set underground, the garbage is less affected by conditions of the weather. Hundreds of these receptacles were sold in Rochester in the last year, many architects specifying them.

The rights for the receptacle are owned, under lease, by J. F. Norris, Norris and Nursery streets, Rochester, who manufactures the receptacles and the molds for making them, and who supplies the cast iron parts which form the rim and the lid.

A New Adjustable Step Form

Concrete steps are always more or less of a problem. The accompanying illustration shows a step form recently put on the market by H. L. Park, Reading, Mass. This is an all-steel frame 27" long and of adjustable height from 6" to 8". The rear portion of the frame, 12" long, can be raised or lowered to make the adjustments for height. One-quarter inch markings are placed on the frame so that height adjustment can be made very easily.

The frames are fastened together to make the stair horse or stringer by passing the eccentric hand-clamp shown at *a* through the slotted portion shown at *b*. The two frames are locked together by turning and clamping the eccentric.

This steel frame is a development from the well known Park wood step form, which has already been described, and its operation is essentially the same. Starting at the bottom, and with a good back support, a pair of the frames is placed. The riser board is held in place by topping it against points shown at *c* and the little hook *d*.

surface of this base is attached pure asbestos felt, while the lower surface is protected by a coating of crushed quartz. Both the asbestos and the crushed quartz are embedded into their respective surfaces while the asphalt is hot and they are therefore permanently attached. Due to the advancement made by the Asbestos Protected Metal Co. in permanently coloring asbestos felt, "Aegisroll" roofing can be furnished in a variety of attractive colors.

A New Lehigh Office in the South

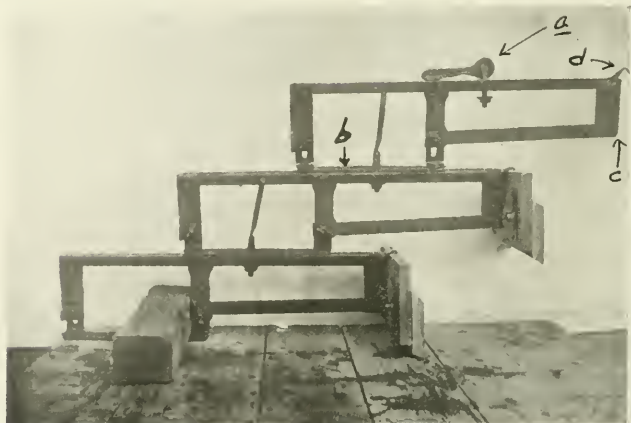
The southern sales office of the Lehigh Portland Cement Co. has been opened in the Savannah Bank & Trust Bldg., Savannah, Ga. L. Alden Smith, Dist. Sales Mgr., is in charge.

This office will cover the states of North and South Carolina, Georgia and Florida, the territory in which "Lehigh" was formerly distributed by the Southeastern Lime & Cement Co. Stocks will be maintained at all times at the southern ports.

A New Prepared Roofing

The Asbestos Protected Metal Co., Beaver Falls, Pa., is marketing a new form of prepared roofing which has been named "Aegisroll." The body or base of this roofing is wool felt, impregnated by waterproofings and completely enveloped in a coating of asphalt compounds. To the upper

Beginning Jan. 1, 1914, the Charles Warner Co., Wilmington, Del., discontinued the sale of Nazareth cement in Wilmington, Delaware, Maryland and Virginia districts. This company will sell Bath Portland cement, produced by the Bath Portland Cement Co. The Bath plant is at Bath, Pa.



DETAIL VIEW OF ADJUSTABLE UNIT STEP FORM

The Use of Steel Wall Forms for Retaining Wall Construction



FIG. 1—A COMPLETE SECTION OF CONCRETE RETAINING WALL, SHOWING STEEL FORMS IN PLACE

In extending the plant of Hubbard & Co., Pittsburgh, the firm of Pihl & Miller is using an outfit of Blaw¹ wall forms for the foundation work, and has recently employed these forms in the construction of a retaining wall of the heel-toe type. The foundation of this wall is in clay on a hillside, and the wall above the foundation is about 9 ft. 9 in. high; it is 15" thick at the base, and 12" thick at the top, and heavily reinforced with steel.²

This wall is poured in a block of 25' at a time for the full height of the wall. The contractor is using a sufficient quantity of steel wall forms to cover 50 lin. ft. of wall, and is separating the work into blocks, with wooden bulk-heads which are enclosed by the forms. Fig. 1 gives

a good view of a portion of the completed wall, with some of the forms still in place in the foreground. These forms consist of panels 2' x 2', with angle irons used for horizontal liners; the forms are connected together so as to form longer panels, which are shifted as a single unit, five or six of these panels making a long panel, 2' high and 10' to 12' long. This panel is handled as one piece every time the forms are shifted. In this way the work is carried on with great ease and rapidity.

The forms are left in place on this work at this season of the year for an entire day after the concrete is poured. Thus, with forms enough to cover 50' of the wall, the contractor takes down, sets up and fills the form for 25' of wall each day, leaves it in place another day while performing the same operation with another 25'

of forms. The surface of the wall produced with this form is smooth and true, and the cost is much below the cost of using wooden forms on a similar structure.

THE WIRE TIE USED

One of the most interesting and valuable features of such a light steel wall form for work of this character is the wire tie,³ which is employed to keep the forms from spreading, and left in the wall, the ends of the tie being clipped off after the wall is finished. These wire ties are entirely different from the wire ties commonly used with wood forms, because they are made up on a frame before being placed in the wall, so that each tie is of exactly the same length and strength and cannot yield in any way.

The method of placing these ties in the form insures a uniform thickness of wall, as the ties are inserted through slots provided for the purpose, after the form is set up, and

³This tie, and the method of making it, were described in detail on p. 193 of the Oct., 1913, issue of CONCRETE-CEMENT AGE.

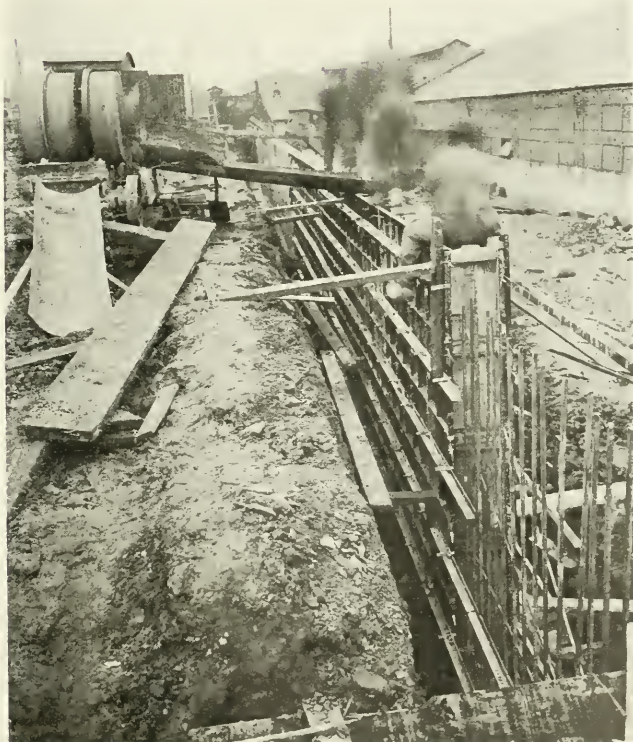


FIG. 2—THE WORK UNDER WAY AT HUBBARD & Co's. PLANT, USING STEEL FORMS FOR RETAINING WALL

¹Blaw Steel Const. Co., Pittsburgh

²Carnegie Steel Co., Pittsburgh

secured by keys that cannot cut into these steel keys as wires so commonly do into wooden supports.

If it is desired to remove the form the keys which secure the wire ties are removed, being very readily driven out with a few blows of a hammer. The form may then be taken away from the wall, leaving the ends of the wires projecting. These are subsequently cut off with end cutters.

Ledgers are applied to the form in both horizontal and vertical direction, the vertical ledgers being placed as a last operation after the form is otherwise ready to receive the concrete.

Some bracing to maintain proper line is of course necessary, but the amount of bracing is very small in comparison with that usually required on work of this character, as will be seen by an inspection of the cut, which shows the form with the mixer in operation while concrete is actually being placed in the wall.

It will be observed that the figures of the men in this cut are very indistinct, owing to the motion of tamping, while the concrete is placed; but that the form is quite distinct as it is undisturbed by this operation.

THE CONTRACTORS' COMMENT ON THE WORK

Pihl & Miller, the contracting engineers for this work, in a recent letter to CONCRETE-CEMENT AGE, discuss in detail some of the factors involved in using steel centering instead of wood. Some paragraphs from the letter follow:

For this class of wall work it usually costs us in the neighborhood of 5 cts. to 6 cts. per sq. ft. for wood forms. Using steel forms practically cuts this figure in two. We hoped to keep the figure under 2 cts. per sq. ft., but have not succeeded in this case.

Before using the forms each time we oil them well. This oiling has proved an advantage, as no concrete adheres to the surface when we have removed the forms. The finished wall requires neither patching nor plastering to repair any unevenness. These forms can be placed by what is known as carpenters' helpers or handy men, being paid from \$2.50 to \$3.00 a day. It is wise, though, to have in this gang one man, preferably a carpenter, to do the final necessary lining up and leveling.

Another very material advantage in using steel forms rather than wood forms is that all material which is poured into the forms remains there,

particularly the thin grout which is essential in first-class concrete work.

Up to the present time we have used these forms about 25 times and they have received no marks of wear. We expect on this job to use them about 75 times and have practically what we started with.

Insuring Against Drought With Concrete Silos

In a recent letter to CONCRETE-CEMENT AGE, H. T. Genung, of the Polk-Genung-Polk Co., Fort Branch, Ind., calls attention to the way in which a continued drought brings out active interest in concrete silos. The letter follows:

"The drought, which our agricultural sections have been and are experiencing, has added a stimulus to the silo business that is almost beyond belief. But why shouldn't this be the case when reason and common sense are so evident in the following argument:

1. Corn is going to fall far short of average yield; say it drops to 30 bu. per acre—only about a ton in weight. The ensilage from an acre of this corn will weigh, granting that the stalks are stunted, about 10 tons. *The difference between 1 ton of grain and 10 tons of ensilage is the difference between loss and profit.* That's too much difference to neglect.

2. Suppose that most of last year's enormous corn crop had been siloed instead of, as a good quantity of it was, sacrificed at a low price—to what extent do you think the calamity of this year's drought would have been averted?

3. If there were an insurance company insuring the weather on the same premium scale as is involved in a silo investment, farmers would "fall" for it even more rapidly than they do for the silo, yet that is just what a rightly siloed corn crop does—it insures the farmer against weather and climatic eccentricities.

"We have been for years urging this feeling upon our constituents. We have advanced this argument to the cement companies for the same length of time,—the latter are now pushing harder than almost anyone else, for the numerous trials, tests and trying experiences good monolithic concrete silos have withstood, remove every particle of scepticism even from our own minds."

Trade Publications

Steel Sheet Piling—Wemlinger Steel Piling Co., N. Y. C., 9" x 4", paper, 24 pp., illust. This catalog is a conveniently sized booklet describing in detail many interesting applications of light corrugated sheet piling. This book is issued as a preliminary to a large, more complete publication which has been delayed in preparation.

Smith Mixer—T. L. Smith Co., Milwaukee, 9" x 6", paper, 54 pp., illust. This catalog is a generously illustrated, comprehensive compilation of Smith mixer models and their work. Many interesting plants are shown and the Smith mixer models are described in detail.

Traveling Cranes—Pawling & Harnischfeger Co., Bulletin 401, Milwaukee, 9" x 6½", paper, 20 pp., illust. This bulletin, punched for binding in covers, describes in detail the essential features of Type H crane. A page in the introduction of the booklet lists the salient features of this equipment. Illustrations show the parts in detail.

Gears. The Simonds Mfg. Co., Pittsburgh, 9¼" x 6", paper, 106 pp., illust. This catalog covers comprehensively the line of gears manufactured by this firm. Of more than usual interest are the booklet's 24 pp. of useful information.

Special Shovels—Conneaut Shovel Co., Conneaut, O., 8½" x 5¼", paper, 22 pp., illust. This catalog illustrates completely the line of Conneaut "Special" shovels. These shovels are hand-made by special process. All styles are shown.

Northwestern Concrete Machinery—Northwestern Steel & Iron Wks., Eau Claire, Wis., 11¼" x 8½", paper, 64 pp., illust. This catalog describes comprehensively the entire line of Northwestern equipment. Cone batch mixers, wheelbarrows, crushers and concrete product equipment are described in detail.

Concrete Reinforcement—Buffalo Steel Co., Tonawanda, N. Y., 8¼" x 3¼", paper, 10 pp., illust. This folder shows illustrations of many interesting buildings in which concrete has been used.

The Economy of Bulk Cement—Universal Portland Cement Co., Chicago, 9¼" x 6¼", paper, 18 pp., illust. This is an artistically prepared and well-presented booklet presenting a hard-hitting, comprehensive argument in favor of bulk cement. Especially effective are the small illustrations showing in detail how sacks are wasted on the job. Many interesting descriptions of bulk cement plants are shown.

Coltrin Concrete Mixer—Knickerbocker Co., Jackson, Mich., 9" x 6", paper, 40 pp., illust. This is a well-prepared catalog covering in detail the essential features of the 1914 models of the Coltrin mixer. Detailed illustrations show the operation of all the parts. The publication is an interesting and artistic catalog.

Pennsylvania Cement—Pennsylvania Cement Co., N. Y. C., 6" x 3¼", paper, 8 pp., illust. This little booklet presents in a very brief way some of the interesting uses of Pennsylvania Portland cement. A view of the construction plant at the Equitable Bldg. is shown.

*Standard Scale & Supply Co., Chicago

Concrete-Cement Age

Vol. 4.

April, 1914

No. 4

The Beauty and Economy in Simplicity

IN just what measure the economical development of the concrete house demands a new architectural thought is brought out in a description of residence construction by Irving J. Gill, San Diego, Cal., in this issue. The article considers the matter more in architectural than in structural detail. While there are few architects who will be inclined to adopt Mr. Gill's methods in assuming the responsibility of actual construction, in addition to that of design and superintendence, and while not a few will think that he has approached an extreme in architectural simplicity, nevertheless there is the thought in the account of the work that there has been in this instance what may be properly called a *feeling of the material concrete*. The quality of the material has been drawn upon to do its utmost along those lines of simplicity—naturalness—which give economical, sanitary and beautiful results.

The New Concrete Stone

THERE is added emphasis in this issue upon the development which is taking place in the production and the use of plain and decorative concrete units, particularly in dwelling house construction.

The concrete block of a decade ago, often poor structurally, and impossible architecturally, is rapidly being crowded out of the field. The block which is structurally poor either because of ignorance or greed, must be utterly abolished. The block which is sound and of good material will continue to occupy a place in the building world, whether or not it has any claim to architectural value. It will be used in foundation work where it is out of sight and in the walls of such buildings as are thought not to require any semblance of beauty. And while it will be hoped that the extent of work in which beauty is considered a requisite may grow, there is no quarrel where personal taste is the only basis for argument. Yet, as the attractive concrete units are constantly becoming available over a greater territory owing to the advance in skill and in architectural appreciation of the products manufacturers, we shall see more and more of such work. Architects will not long ignore a

building material which offers such possibilities as does the *new concrete stone*. This new concrete stone can be made in some of the same machines as the concrete block of old, or it may be a special molded product. In the future it will not be the product of a poorly considered mixture of whatever a man chooses to throw together in a mold. It will be the definitely specified product required by the user for a definite result.

Build Fire-Proof Homes

STANDING guard at a blackened ruin, where the charred remains of what was a home are a wet, black mass in the hole that was the cellar,—we have all seen the chimney, standing stark and grim, a warning to men to build of fire-resisting materials.

Men are inherently fire-worshippers. From earliest times—around fires of many kinds—have grouped the mystery and the magic of the developing races. In what we have been but very recently prone to call our "modern homes," burnable wood construction, wood walls, floors, roof and stairs, fire has been our servant, our enemy, and too often our demon master.

Fire should be man's friend—to serve and comfort him. In the dread of fire, in that state of living in constant fear of fire—in that necessity of constant precaution against destruction by fire—in your very home—in the heart of your home, the fire place—mankind is losing much.

Leave out the toll of lives and the loss of property, and consider alone the damage—not measured in personal or material terms—but the damage wrought by fear and anxiety.

One incident illustrative of this comes to mind at this time. There was a home on a hillside in a Jersey suburb in a frame cottage. The neighbors, too, lived in frame cottages which dotted the hillside. In a short twenty minutes one spring afternoon—with everybody awake and about—fire changed one of the houses to a blackened ruin. What household goods could be saved were piled in neighboring yards. Can such tinder-boxes be called *homes*?

Today, in a 30-year-old brick house, wooden floored, in the upstairs nursery, an open grate fire is

the center of interest. A banked fire kept through the cold nights, is a comfort. A live coal falling out of the basket—a defect in the chimney—any one of many possibilities—would convert that house into a furnace, with us inside.

Under such possibilities for destruction, we have in the past been compelled to live. We have had to house our wives and children, shut up—locked in—in tinder-boxes—nursing the demon fire in their midst. If all the hours of fire and worry caused by the possible fires in American homes could be summed up, what an appalling total it would mean. We have paid bitterly for tinder-box construction of American homes. The currency has been human lives and happy homes. We have learned to fear fire and to hate it.

This is not a discussion of concrete houses—so much as it is an earnest plea for *fireproof homes*. Consider today what is offered the modern house-builder. For exterior wall construction concrete, block or poured, tile, stucco and brick—each makes its appeals in different ways. In the long run and all things considered, many of them are cheaper than clapboards. The emphasis today must be placed on fireproof floor, stair and roof construction. For fireproof construction of these parts concrete in some form or another is absolutely essential from every practical standpoint. At a given cost, concrete, in walls, floors and roofs, offers to the home builder the biggest value in every way.

Consider the contrast in modern fire-resisting concrete home building. A fireplace is put up on the roof where it can be enjoyed by all, where the air and sun and sky and stars and fire are true companions. In another home (shown in this issue) a fire burns in a basket in the center of the room; a hooded smokestack carries off the smoke. The fear of fire, the worry and anxiety over it, are banished for ever.

It has been said that a man's home is his castle. Is it true so long as the traitor demon, fire, is nourished within? Is it not true only when the house is fire-resisting in every part? Fire-resisting house construction, making fire a welcome and unfearful friend, will add much to the happiness of mankind. Build fireproof!

The Force of Example

TODAY we know definitely of over twenty corporations, municipal and industrial, which have under way a program of housing construction. There are probably as many more under way about which no information is available. Another hundred corporations, at a guess, are considering building homes for their employees.

Each one of these means from half a dozen to half a thousand homes, and concrete is the material being used.

To illustrate this, let us cite some typical examples. At Midland, Pa., the Crucible Steel Co. is building a group of monolithic houses. These are being built at a cost less than that of frame, are fireproof, and while not exactly dirt-proof, they are dirt-resisting for they can be cleaned when necessary with a hose. Similar houses have been built at Nanticoke, Pa., and at many other points.

It can be said safely that in recent years whenever any real estate or housing development has been undertaken by a public or a private corporation which has had a permanent interest and pride in the work done, wood frame houses have not been built, but more permanent materials have been used. In the nearer past, and in the best developments, concrete has been used throughout, offering, for the requirements, an ideal home.

Look ahead five years and see what this is going to mean. Our workers will be able to buy on easy terms or occupy at low rentals good substantial fireproof homes. A builder said some time ago, "the rich man can afford a wooden house; the poor man can not." No paints, no insurance, no fire loss, lower coal bills, comfort in summer and winter, will bring into striking contrast the values of the concrete cottage occupied by the working man, and the frame cottage, the residence today of the average salaried man.

Where do these tinder-box frame cottages come from? The biggest single source is undoubtedly the modern real estate development companies, which go out to the outskirts of our American cities, usually in advance of a projected car line—buy farm lands, and develop them under fancy names—into "swell suburbs."

They build to sell, and they usually "get out from under" as soon as they can. They leave the other fellow to "get out and get under" every day of his life, staggering under the load of the upkeep cost of a frame cottage.

Every great reform has come from below—up from the masses. The magnificent concrete residences which are being built can not be considered examples which the average man can follow, and we must meet the need of the average man, must offer him the "home universal" before the great development in concrete houses will come.

This issue describes a concrete house built monolithically, floors, walls, roof and stairs. Such a house can be built as one of a group, with efficient equipment, for less than \$1,000. This same house, somewhat larger and more elaborate, and under the same general conditions, could be built for a definite, and not excessive increase over that figure, and at a figure well within the reach of the average man. Ask yourself this question: If an industrial corporation can build a house like this for \$1,000, why can not a real estate corporation, with similar equipment, and similar methods, build a somewhat similar house for \$2,000? What could such a company do for \$3,000 or \$4,000, or \$5,000?

The great reward, financially and in the deep-felt gratitude of happy clients will be for those real estate corporations who will do this very thing.

The next decade will witness a most wonderful change in our housing conditions. These little box-like cottages are the seed from which our houses, the homesteads of the average man, will come.

The Ideal and The Possibility

CONCRETE Homes for Everybody. This is an ideal; we are approaching it as a fact—not that everybody specifically will live in a concrete house but that the material is now such as to offer the best possible results in safety, comfort, economy, sanitation, permanence and beauty to meet the limitations of modest investment or to realize more ambitious schemes for grandeur and luxury.



FIG. 1—CONCRETE HOUSE BUILT FOR HENRY H. TIMKEN, SAN DIEGO, CAL., IRVING J. GILL, ARCHITECT

An Instance of Economy and Simplicity in Concrete House Building

BY REED ROBINSON

The essence of art is simplicity. Only the true artist can afford to be simple, direct and unadorned in his creative work. Art production consists mainly in the elimination of the non-essential.

American architecture is a curious thing, since it is not distinctive as such. Indeed, the phrase "American architecture" is almost an anomaly, since to a considerable extent it is bound to conventionality. Irving J. Gill, San Diego, Cal., is an American architect who has no use for conventionality. His architectural creations are practical art, distinctive and indi-

vidual. He has boldly and broadly forsaken conventional architecture.

Mr. Gill's specialty is the creation and erection of habitable homes. For a quarter of a century he has devoted his talents to designing and building beautiful homes in sunny southern California. And his work has been pronouncedly individual. It has been artistic and utilitarian.

Mr. Gill has deliberately limited himself to the cube, the hemisphere, the rectangle and to segments of circles in developing a style of architecture which is not only unique, but beautiful and practical as well, in its

simplicity. Possibly this is the American architecture looked for as distinctive of the country, yet found generally only in towering skyscrapers.

The plain surface unbroken by cornice or window ledge, the severe arch without column as support and a rectangular skyline, relieved only here and there by the curve of an hemispherical dome, or the graceful and casual figures of a growing vine, are the contours and surfaces used exclusively in the Gill designs.

Another feature which Mr. Gill makes a distinctive point in his work



FIG. 2—FRONT, NORTH, VIEW OF TIMKEN RESIDENCE



FIG. 3—COURT OF TIMKEN HOUSE LOOKING SOUTH TOWARD GARDEN



FIG. 4—GARDEN VIEW, SOUTH FROM CHILDREN'S COURT

on residences, is the effect of reflected colors upon a white or a neutrally tinted, unbroken surface. To the discerning observer of color the plain white surface is composed of delicate and changing hues which takes tones from the greens of the lawn or tree, the blue of the sky and the multiple shades of the varied flowers. The splashing warmth of crimson from a geranium bed, together with the varied lighting of morning or afternoon, clear or cloudy weather, produce effects upon these walls that are a delight to the eye.

This idea of reflected colors is employed by Mr. Gill not only in connection with the outside walls but in

planning the lighting of interior rooms. The walls are designed with surfaces as flat and unbroken as possible. They are finished in a plaster surface slightly roughened. The ceiling is tinted a light neutral shade. The side walls are tinted likewise though the color is a shade deeper than that of the ceiling. The result of this treatment is such that ceiling and walls take on the hue of the dominant color note in the furnishings. This makes the rooms especially delightful to the eye and extremely restful for the occupant in the matter of light and color. This idea is characteristic of every Gill house.

From the standpoint of the owner it is eminently satisfactory to note that a Gill house is much cheaper than that of most others. The comparatively low cost of the Gill houses is largely due to the fact that concrete is the only material used and Mr. Gill's ideas of simplicity of line in architecture make the very most out of the material concrete. It is such use of concrete which is most economical and which is most characteristic of the material. Wood is employed but sparingly, and this for interior finishing of doors, windows, stairways, etc. Mr. Gill, by the use of concrete, has been able to produce handsome and distinctive residences. By the use of

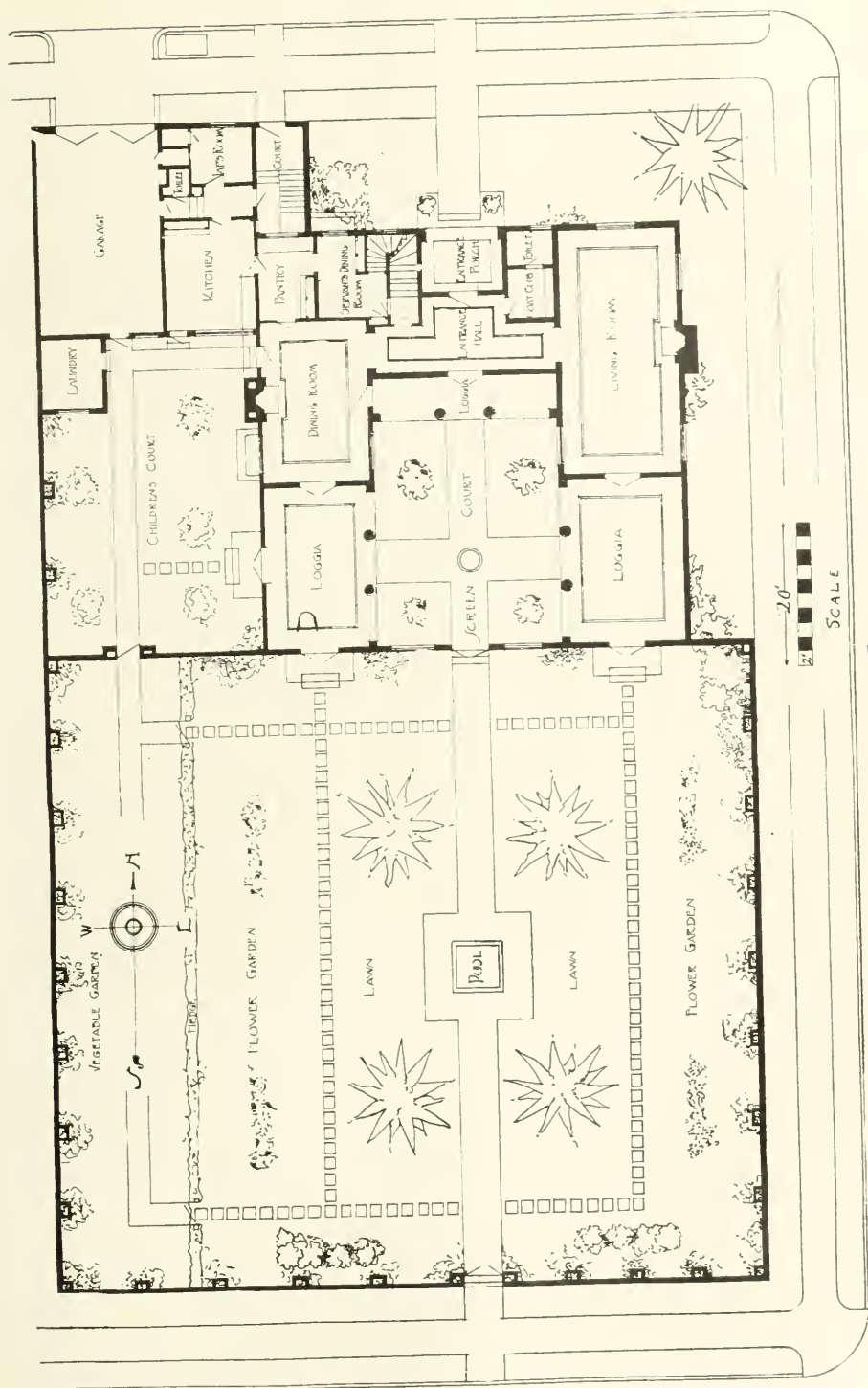


FIG. 5. PLAN OF TURKISH HOUSE AND GARDEN

concrete Gill structures are built at a cost lower than corresponding construction could be done with wood or other material.

In a general way Mr. Gill figures concrete in house construction such as that here illustrated at approximately 30 cts. per cu ft. in place. He figures the walls at 10% of the building cost.

Mr. Gill designs the house, obtains the approval of the owner and undertakes the erection of the building. He buys cement directly in large lots, paying spot cash. He thus obtains all the benefits of discounts for cash and is a preferred customer with the firms which supply his building materials.

Mr. Gill arranges with the owner to deposit with the Gill firm a sum of money covering the estimated cost of construction. It is only in rare cases that the construction cost exceeds the estimate.

By Mr. Gill's plan, the percentage cost to the owner is a flat 15%. The idea has proven so essentially practical, effective and efficient that he is constantly besieged with business offered for his handling. As an instance of saving he buys cement at \$2.60, whereas the average cost to owner is \$3.00.

Of the houses designed and erected by Mr. Gill, the one here illustrated was built in San Diego, Cal., for Henry H. Timken, Canton, O. The Timken house is a representative specimen of Mr. Gill's work. It is built entirely of concrete. It embodies his unique ideas of construction, of arrangement for domestic purposes and a style of architecture, so unusual in America, wherein the garden is made an integral part of the residence itself, as well as of the home life.

The Timken residence is also an excellent illustration of the Gill mode of building a house. The estimated cost was \$19,800. Mr. Timken then banked, subject to Mr. Gill's order, the amount of the estimate. The prospective owner then left the city and returned to his home in Ohio. He left entirely in Mr. Gill's hands the erection of the residence as planned. The next time Mr. Timken returned to San Diego the residence was turned over to him finished, and within the original estimate of \$19,800. The contract between Mr. Gill and Mr. Timken was closed during the winter, the house was completed the following spring and turned over to Mr. Timken and his family for occupancy on their arrival in San Diego thereafter.

The accompanying illustrations show the Walnut street facade, a per-

spective of the building and garden-wall as viewed at the northeast corner. Reference to the ground plan shows the walls of the house and the walls of the enclosed garden built all as one structure. The house is 90' x 75', the garden 100' x 88'.

The climate of southern California the year round is so balmy, genial, sunny, warm and rainless, especially in San Diego, that the usual protection against the severity of the elements is unnecessary.

The Timken home is at the southeast corner of Walnut and Third streets. The house faces north in Walnut street. The garage, kitchen, pantry, servants' quarters, dining-room and entrance are all built into the house proper and open upon Walnut street, in itself a most unusual house plan.

The principal entrance faces Walnut street. Entering the main hall one passes directly into a large screened court, which is practically an open-air garden with growing flowers. The large court, as can be seen from the floor plan, is in reality the family living room, the center of the home life. An overhead copper wire screen keeps out the flies. Vines have been planted which wreath the pillars and trail from the porch supports to the large screen. Ferns and flowers are growing in the outdoor room, potted plants are placed in sun or shade as they prefer, and a flowing fountain tinkles musically in the center. It would be difficult to find a more homelike or charming place. The fountain and court feature of the Timken house is in principle the same as that of the old Greek homes built on the atrium plan, with basin in the center. These outdoor rooms are a common feature of Californian domestic architecture.

At one side of the screened court, as shown in the floor plan, is a similar court given over entirely to the children's use. A charming complementary of the screened court is the walled garden which is a part of the home itself. The long concrete garden wall is structurally unusual. The buttresses are large and hollow-built; filled with earth, and vines grow from them and drape the walls.

A broad concrete walk extends through the center of the garden leading from the screened court. Midway, this walk is broken by a concrete pool on either side of which the walk passes. A stepping stone path extends around the entire garden. This path is made of a series of four 8-in. tiles held together by a wide mortar joint, to make 18-in. squares. These squares are each separated by the turf of the lawn.

Wood forms were used for the entire construction—walls, floors, stairs and roof. The first floor and garden walls are 12" thick and second story walls 8" thick. Finished floors are 8" thick with 3/4-in. twisted rods for reinforcing 1 1/2" from bottom of slabs. The concrete stair slab is 4" thick in net section and reinforced with 3/4-in. twisted rods laid full length of the stairs at the sides of the stair. The roof is a 6-in. slab reinforced with 1 1/2-in. Rib'. The walls are reinforced with Elwood wire fencing, 4-in. triangular mesh, placed 1 1/2" from outer surface. In general a 1:3:5 mix of cement, sand and gravel was used. It is Mr. Gill's policy, however, to change the mix from time to time, depending upon tests of sample concrete from the materials available. Concrete was conveyed in wheelbarrows.

After the removal of the forms the outer wall surface was smooth stuccoed with a heavy coat of a mixture of 1 part cement to 1 part sand with a 5% admixture of hydrated lime.

A special feature of this house, as in fact it is with all Gill houses, is that interior woodwork is finished flush with the walls in every part of the house. All doors, whether leading from room to room or into cupboards and closets, are built without panels and set flush with the casings which, in turn, are flush with the walls. This feature makes a practically dustproof house and eliminates a distressing item of housework. Not only that, it makes the rooms more sanitary.

Drainboards and backs of sinks are of magnesite. The magnesite slabs are finished flush with the walls. Corners where they meet the sink are rounded, eliminating cracks in which grease or dirt may collect and doing away with exposed wood to become sour and decay from constant wetting. Bathtubs are boxed, then covered with magnesite up to the porcelain tub edge and finished with rounded corners. Bathroom floors are of magnesite with all angles rounded. This construction in the bathroom renders it easy to keep clean and wholesome. In fact, there are no cracks, corners or crevices, projections or sharp edges in the entire structure.

The use of concrete in carrying out these ideas in house construction makes them practical because concrete as a building material is inexpensive, adaptable, reliable and lasting. Through the use of concrete Mr. Gill attains these effects at a saving of time, cost and labor and with the certainty of satisfactory results.

¹Trussed Concrete Steel Co., Detroit

“Manufacturing” Concrete Houses at Low Cost—Work at Midland, Pa.



FIG. 1—A GENERAL VIEW OF CONCRETE HOUSE UNDER ERECTION AT MIDLAND, PA.

This shows the concrete mixer, tower, chutes, etc. Behind the tower is shown a practically completed house. In the foreground are shown steel forms in place for the walls and second floor of the second house

We are living in a machine age. To the greatest possible extent, our products are today universally machine made. Hand labor is expensive in every case where the output is large enough to warrant mechanical equipment. The following notes describe some recent developments in house building equipment. With such equipment, this work becomes about 90% a machine product; the hand labor effort, if the term may be used, reduces to about 10%.

At Midland, Pa., the Pittsburgh Crucible Steel Co. has recently finished some concrete houses, which offer, in the construction methods used, many interesting features.

The four houses completed have been a trial lot, as it were, and so far everything has gone very satisfactorily.

The accompanying sketches (Figs. 2 and 3) indicate the general arrangement of the dwellings. The houses are rectangular in plan, 29' x 18' outside measurements, 27' from grade to cornice. The walls are 9" thick.

Each floor is divided by a cross-

wall into two main rooms, and the stairs, going up from the front room, are of concrete.

These houses were cast in steel forms,¹ the essential features of which are story-height built-up panels of steel in channel section, held in place by horizontal steel stringers. The concrete was mixed in a small

¹Developed by F. D. Lambie, pres., The Am. Bldg. Corp., N. Y. C.

rotary batch mixer,² hoisted in a bucket² and distributed by gravity chutes.²

The two houses shown in the accompanying illustrations were finished in December last, and were completed in about 12 days' working time per house. The concrete plant was placed to the rear and midway between the two houses, so that the same concrete distributing system could be used for both.

STEEL FORMS USED

With the footings in, the wall forms are set up, one panel at a time. These panels are held together by a little slotted "T" bolt and a wedge. The stem of the "T" is placed through adjoining holes in the sides of the panels, a wedge is driven through the slot in the stem of the "T" and the plates are held tightly together.

The inner forms are held in alignment after the entire panel or wall side is erected and pinned together by an I-beam running horizontally back to another series of forms. These I-beams rest on top of the angle-iron ledgers, being pinned down there with a clip. The I-beam stringers are made adjustable so that they can be contracted or elongated as required. These horizontal I-

²Ransome Concrete Machy. Co., Dunellen, N. J.

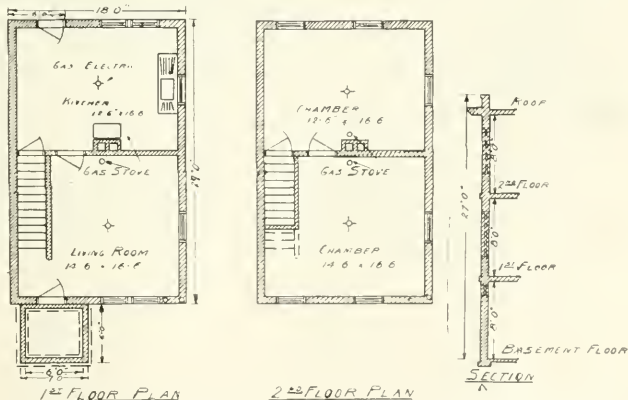


FIG. 2—SKETCHES SHOWING ESSENTIAL ARRANGEMENTS OF LOW COST CONCRETE HOUSES
CONCRETE-CEMENT AGE

beam stringers serve also to support the floor plates, so that the walls and floors can be cast at one operation. The outside wall plates, belting course, etc., are held to line and perpendicular by an iron rod running clear through the belting course. At the lower part of the belting course, these joints come to a horizontal plate made of ship channel 6" wide. This channel fits over the top of the outer plate.

The walls and floors are of solid concrete, reinforced with 1½-in. round rods, 6" o. c. in both directions. With the steel forms and the concrete equipment, that is, a complete plant, only five men on an average were required to do the work. The wall forms were removed the day after pouring, with the exception of the horizontal stringers at the top which support the floor forms. The same panels are used for floors and walls.

The concrete used was a 1:2:3 mix, using sand and gravel from the Ohio river.

The surface coat on the floor is of a mortar mixed with red oxide of iron, producing, with a gray stone narrow border, an attractive and low cost finish. The top surface was put on immediately following the pouring of the floor.

The roof was finished with a top surface of waterproofed mortar. The interior was finished with a standard interior paint² in two coats.

The houses are equipped with electric lights, gas, plumbing and water, and cost \$890 each. This does not include a bath-tub. Within 3½ weeks from cellar excavation the tenant moved into the house shown in Fig. 1.

The equipment involved an investment of about \$5,000; \$3,500 for the steel forms and \$1,500 for plant, including mixer, hoist, chute, etc. With



FIG. 4—THIS IS THE SAME CONSTRUCTION SHOWN IN FIG. 1 FROM ANOTHER ANGLE. This shows a closer view of the steel forms, angle ledgers, ceiling plates, etc. In the background is shown the completed house



FIG. 5—A DETAILED VIEW OF A COMPLETED HOUSE, MIXING PLANT, TOWER, ETC.

This shows in detail the completed house, the cornice, panel parapet, etc. The small rotary batch mixer is also shown in detail

¹Universal Portland Cement Co., Pittsburgh
²Ceresit waterproofing was used, Ceresit Waterproofing Co., Chicago
³Patton Paint Co., Milwaukee, sold by the Pittsburgh Plate Glass Co.

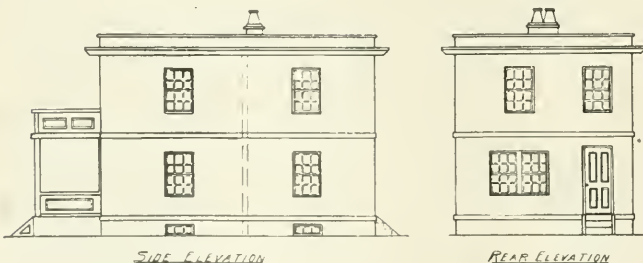


FIG. 3—ELEVATIONS OF HOUSES

a number of houses to build, and with operations well and systematically organized, houses such as shown should be turned out at the rate of about four a month.

The Pittsburgh Crucible Steel Co. cast these houses with its own men, using the Lambie equipment. Present indications are that the Pittsburgh Crucible Steel Co. will proceed with the construction of a number of similar houses with the opening of the building season.

V-Beams and Beveled Open-End Tile Cores in Fireproof Floor Construction

BY FREDERICK SQUIRES¹

Fireproof floors are essential to fireproof construction. The following notes, the results of original and extended investigation, are more than a discussion of a specially shaped tile for floor construction. They are a basic and detailed study of the problems underlying the economic and effective combination of concrete and tile in fireproof floor construction.

When we used to build the old one-way stock tile and concrete beam floors, where the beam was rectangular in section, tiles would occasionally drop out, notwithstanding the bond between the concrete and the tile due to the grooves in the sides of the tile. I have had workmen tell me time and time again that the tile filler ought to be larger at the top than at the bottom so that a mechanical bond would be formed and one would not have to rely on the bond of adhesion between tile and concrete. This, of course, would form a beam in section diametrically opposed to the shape it ought to be according to theory. It was a combination of this lack of faith in the adhesive strength of concrete and tile surfaces, and the fact that a concrete beam should be larger at the top than at the bottom, that led to the discovery of the V-beam and the beveled block.

TWO-WAY REINFORCED CONCRETE AND TILE FLOORS

It may be well to go over the story of the development of cross-wise reinforcement because, in addition to the two reasons I have just given, this is the third step in the development of this new system. A slab reinforced with two sets of rods, each layer consisting of parallel rods and the rods in one layer at right angles to those in the other layer, but rest-

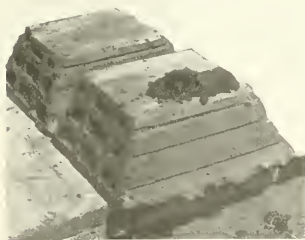


FIG. 1—THE BEVELED BLOCK IN POSITION
This shows the extra heavy horizontal webs in the upper section, the small height of the upper cell and the longitudinal flange on the lower side of the block

ing on the other, will carry the load placed on it to all four of its supports. If all the concrete not needed structurally were removed from this slab it would present very much the same appearance from beneath as a waffle iron. If one desired to pour

the slab itself the forms which would properly shape it would be exactly like a waffle-iron. On account of its fireproof quality and its quality to bond with concrete and plaster and the fact that it is made hollow and

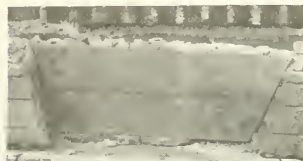


FIG. 2—MAKING A TEST TO DETERMINE HOW FAR THE CONCRETE ENTERS INTO THE TILE

therefore light, terra cotta tile has been successfully used as cores in two-way reinforced concrete floors. It must be remembered that it was first brought into use in one-way



FIG. 3 (ABOVE)—THE VIEW SHOWN IN FIG. 2 WITH THE BOARD REMOVED
This shows plainly the split tile and the way the concrete entered the cells of the tile

FIG. 4 (BELOW)—THIS IS THE VIEW OF THE TILE SHOWN IN FIGS. 2 AND 3 IN WHICH A FINE GRAVEL CONCRETE WAS USED INSTEAD OF 1-IN. STONE

This shows very plainly the extent to which a concrete of quaking consistency will enter into the cells of the tile. The concrete beam shows a section very closely resembling an ideal parabolic beam

¹Arch't., N. Y. C.



FIG. 5—PLACING BEVELED BLOCKS IN FLOOR CONSTRUCTION

In the background, to the left, concrete has been placed, brought to the level of the top tile. At the right in the rear a section of the floor is covered with a 2-in. concrete slab

floors and the two-way tile floor is a development of the one-way.²

OPEN-ENDED TILE UNAVOIDABLE

Hollow tile are made by pressing through dies, moist pulverized clay mixtures, cutting the pressed section into required lengths, drying and burning the green product. This means that the designer and builder of two-way tile floors must work with an open-ended tubular block; and this block must be so simple in outline that it can be made in large quantities and at small expense. This block will be more or less warped and untrue in outline and surface and will be subject to considerable breakage. The top and the bottom will be in horizontal planes but irregular, and symmetrical sides may be formed by the die and the cutting wires. These are innate physical characteristics of hollow tile and are as unchangeable as the number of legs on a dog.

AN ACCIDENTAL USE OF TILE OPEN TO CONCRETE

I have mentioned earlier the fact that a man who does not know the strong affinity that concrete has for hollow tile or burnt clay of any description hesitates very much before he will depend on it to hold his cores in place. Even those of us who have been accustomed to depend on it are not dumbfounded when the bond fails and a block falls out. It is then not surprising that on a job in Amsterdam, N. Y., a contractor, inexperienced in this kind of work, felt that the bond would not be dependable and that to form his one-way

beams he should present the open ends to the concrete rather than the closed sides. It was surprising, however, that when an examination of the completed floor was made it was found that the concrete had not run far into the block. On the other hand, it was perfectly evident that nothing short of the entire annihilation of the slab would ever free the tile from its bond with the concrete.

It is perfectly obvious also that if this contractor had spaced his blocks as far from each other on the closed sides as they were on the open ends, the blocks would have formed a gridiron of channels and when reinforced around each block and concreted between and over them they would have made a successful slab. Such a floor would have many advantages not possessed by a scheme showing a more complicated arrangement of parts. The main advantage would be in the fact that the concrete and the top part of the tile would form a continuous slab and would take compression almost as readily as a monolithic concrete slab. The section of the beam, however, would be the old rectangular section harking back to wood and iron, and, worst of all, the ceiling presented when the forms were removed would consist of a gridiron of concrete all around the tile surfaces and this concrete would unquestionably show through the plaster when atmospheric conditions were favorable to condensation.

EFFECTIVE BEAM SECTION AND AN ALL-TILE CEILING

With the good start just mentioned it would seem that the only improvements necessary to produce a good floor would be a properly sectioned beam and an all-tile ceiling; and all of this without losing any of the sim-

plicity of the construction just described. The beveled block accomplishes both results and simplifies, by automatic spacing, the construction referred to. It would be easy, however, to lose in manufacture the economies gained in field work, but the beveled block is made by precisely the same methods as are used to produce the stock hollow-tile block. From the point where the stream of clay issues from the die to the time it reaches the job there is not a single new machine, nor a single new method used not already in use with the stock material.

Knowing how tile is made and how the methods of making tile limit it, what is our problem in use of tile in two-way floor construction? What are the qualities required in a perfect two-way tile and concrete floor, or, going further back, why should tile be found at all in an ideal two-way construction?

Answering the last question first, I would say that tile is an historic fireproof. Tile is cellular and therefore an insulator; tile forms a strong bond with plaster and therefore is a good ceiling material; tile has a strong affinity for concrete and great strength in compression, and therefore makes possible a strong structure with concrete. Simply as a filler, cubic foot for cubic foot, it is hardly less expensive than concrete which it displaces, yet if any of it can be placed in compression it will cheapen the entire structure by reducing the amount of necessary concrete. Since the concrete beam should not be rectangular in shape even with a top slab, and surely not when the slab is missing, the question arises as to whether or not an open-ended block with horizontal top and bottom can be so designed that

²An early development in two-way reinforced concrete and tile floors, the "Burcharz" system was described in *Concrete Engineering*, Oct., 1909, p. 276

when placed in a two-way floor construction its bottom will be in contact with adjacent tile forming an all-tile ceiling, its sides will section a perfect concrete beam and its top join the beam top or the beam top and top of slab in compression. The answer is the beveled block.

EFFORTS TO DEVELOP TWO-WAY FLOORS

Because of the good qualities of hollow tile in floor forming, many designers have selected it as the basis of their floor form problem in spite of its many limitations. Since its closed sides had long been used to contain concrete beams in one-way floors they fell into the error of trying to reproduce these closed sides to contain the cross-wise beams. The Patent Office shows that one man has tried to do it with tile channels, another by slipping hollow tubes into adjoining tile,³ another with paper, several with metal slides or covers; one has set his tile on end on a tile plate and covered the top with metal or paper; they wrap them with wire mesh, they cover them with gunny sacks.

The best way to close them is to leave them open. It is like a fat man breaking all records running to a fire when there is no fire. They have lost sight of the fact that the one-way method allowed the concrete to come into perfect contact with the tile so that from beam to beam it was in compression. They have forgotten that in covering the open end with a loose member, channel, metal slide, paper or what not, they have left a crack between it and the irregular edge of the tile block and that in this direction there can be no continuous compressive slab.

As to the beam section, they are right enough if they are willing to regard the tile as a filler pure and simple. But this admission admits also that they are using a pretty expensive filler, because the tile costs as much cubic foot for cubic foot as the concrete. Such a filler, viewed solely as a filler, presents a rather heavy dead load and one might begin to question whether or not some lighter filler material might be advantageously substituted. It seems to me that the saving grace of terra cotta tile in two-way floor construction is the fact that it may be made to do real work as well as add a secondary defense against fire, and provide a positive flat plaster surface. In order to do work the concrete in the transverse beams must contact with the whole top of the tile. Dis-

regarding that part of the beam formed by the top plates of the tile which are then in compression the beam itself should not be a rectangle but its sides should approach a parabolic curve.

EARLY EXPERIMENTS WITH THE BEVELED BLOCK

When the beveled block arrived at the operation where the first slab was cast, the desirability of the compression idea, the repeatable unit, the all-tile ceiling and the beam section were immediately granted by everybody. Questions were raised, however, as to the distance the concrete would run into the open ends. In order to find out, experiments were tried before the slab was cast. Sev-

to bear the bulk of the compressive strain. In another part of the same slab the concrete is shown (Fig. 5) as forming a top layer over the beveled blocks.

The depth of the block determined the amount of concrete which must be used, and illustrated conclusively that the strong compressive top plates of tile purposely thickened as shown in the uncovered blocks join in perfect union with the concrete all around them, a sure and figurative compressive slab. It might be called an engineering proposition.

POSITIONING THE REINFORCEMENT

The two-way reinforcement illustrates a further nicety. It will be noted that the closed sides of the tile



FIG. 6—USING MOIST SAND TO STOP UP THE HOLES IN BEVELED TILE

Moist sand has been thrown into the V-beam, pressed back into the openings with a spade, and the surplus swept out

eral tiles were cut in half from open end to open end and a board was cut as shown in Fig. 2, beveled to fit the ends of alternating tile. The split tile was put in its place between full blocks and two sections of the experimental slab were cast, one with 1-in. crushed stone and the other with the very finest gravel that it was possible to procure. After the concrete had set the board was removed and the result was as shown in Fig. 3 for the stone concrete and Fig. 4 for the gravel concrete. It will be seen that the stone ran in hardly at all and that the wet gravel mixture penetrated at no point wider than the top of the beam. This having been settled to the satisfaction of everybody present, the beveled blocks were put in place on the forms, the reinforcement laid in and the slab poured. Fig. 5 and Fig. 6 illustrate this operation. They purposely show a part of the construction in which the concrete is brought to the level of the top of the beveled blocks which would be the position it would occupy in light loads and short spans, where the tile would be counted on

are not cut off on a straight bevel, but eased off by flanges at the bottom. This forms the channel for the lower rod. It is self-evident that the lower, a round rod, descends into a groove as it gets nearer to the sides. Since in the manufacture of the tile,

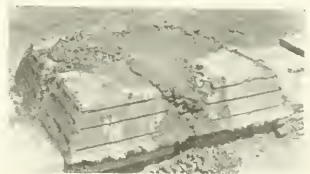


FIG. 7—THE TILE SHOWN IN FIG. 6 FILLED WITH CONCRETE

the wires can cut in planes only, they can produce a section beveled to the open ends only. The die, however, can influence the clay stream in any outline. Hence on the die-formed sides is made the flange and in this channel, formed by two adjoining flanges, is laid the lower rod, which raises the cross-rod laid upon it to a wider part of the V-shaped channel.

³The "Faber" system, described in CONCRETE-CEMENT AGE, July, 1913, p. 18, uses tubes between adjacent tile



FIG. 8. THE TILE SHOWN IN FIGS. 7 AND 8 TORN APART TO SHOW TO WHAT EXTENT THE CONCRETE PUSHES BACK THE MOIST SAND DAM

A careful examination of the tile at the left shows how the concrete has pushed the sand slightly into the tile. It would probably be safe to assume to a certain extent that the liquid part of the concrete has soaked into the sand and when the tile was pulled out that this part of the sand came out with the concrete.

CENTERING REQUIRED AND STRUCTURAL FEATURES

It is obvious that these beveled blocks require the simplest of open centering: they are self-spacing and laid in solid concrete all around with their neighbors so that no amount of ramming of the concrete will displace them. It cannot be denied that the top of the tile being in contact with the concrete at every point and having absolutely no joints must be in compression structurally. The outline of the concrete formed by this filler is as near to the theoretical outline as can be produced with straight lines. The whole floor is a double system of fireproofing and even the concrete around the rod has an outer covering of tile. Where there is no top slab the thickness of the tile insures the depth of the beam which is an advantage where carelessness or dishonesty might lead to reducing the amount of concrete below what had been figured as safe.

CLOSING TILE ENDS WITH SAND

It is never well to put all your eggs in one basket. It is also never well to get too fixed on one idea. The man of one idea is sometimes only a bore, but if he keeps thinking about it too much they may have to put him somewhere where he will only bore the keeper. So it is sometimes with concrete, and concrete thinkers. Luckily, the difficulty here is to keep one's mind down to the contemplation of just the things that his mind can handle since exploration is so alluring. I have given thought to concrete in many lines and I have found that each helps the other. The reader may have seen the description of the pyrobloc,⁴ and may remember as well the discussion of sand molds⁵ for concrete ceil-

ings. The use of sand and the way it would pack opened the way for another development of great practical value. All sand is molding sand. The best is only the minutest, and is obtained by running sand through water in which the finest particles will float for a while and settle further down the current. This accounts for the packing quality of beach sand, but all sand will mold when damp. It is a demonstrated fact that concrete cannot pass packed molding sand. This means that we can stop the open ends of the beveled block for all who want it that way. Fig. 7 shows the experiment blocks in place. Its ends have been stopped with molding sand just as we are now going to prepare our experimental slab. The ends of these blocks are sand-stopped, this having been done by throwing some loose sand on the tile, working it into the tile with a shovel and sweeping out the surplus with a broom. The packed sand may be swept back from the face of the block as little or as much as one sees fit and upper openings not filled at all if so desired. The sand does not destroy a single excellency that was in the former beveled block. It still has perfect contact, perfect mechanical bond and perfect simplicity in arrangement for concrete beams and all-tile ceiling. It adds a perfect stopper for the concrete, put in at little or no expense of material and labor, using a material which actually cures concrete. Fig. 8 shows the experimental slab after the side boards have been removed. Has the concrete driven in the sand and filled the block? In Fig. 9 the slab has been torn apart and the sand can be seen just where it was in Fig. 7. And very little sand is required.

ADVANTAGES OF THE USE OF SAND

The advantage of this as a tile stopper is that it does not have to be

considered in the arrangement of the blocks which has played havoc in other instances. The wetter the concrete, the surer the sand dam. The sand packs most readily on the ledges of the beveled ends but would be efficient with a stock block as in our imagined two-way case in Amsterdam, or any other open tile device.

FIREPROOFING VALUES OF CONCRETE AND TILE

Whatever the fight may be in certain municipalities over the comparative fireproofing qualities of tile and concrete, each side must admit that the other has great claim to consideration. I think it must be admitted that the further one goes in tile and concrete construction the more one must subordinate tile to concrete as a positive structural factor. On the other hand in certain kinds of work tile seems to be more adaptable and at the present stage in the game the concrete man would be foolish to dispense with the assistance that he can get from tile. When he needs a fireproof filler and insulator he would do well to give it grave consideration. Where he can work tile into the compressive area of the slab he can make it stand strain as well as form insulation. There is hardly a material which has a better suction for plaster than tile and this must be a claim which will have weight with the concrete man whose material has sometimes proved unsafe as a surface for plastering.

The mistake of the Amsterdam builder helped develop the beveled block. The difficulty of producing a T-beam in the two-way system was removed by a builder's inadvertent effort at a mechanical bond. Approaching the problem from the theoretical point of view and trying to obtain a tile filler which would produce a beam as nearly according to the theoretical outline as was possible with straight lines, a result was obtained and a tile core was developed which could be manufactured with the same processes as were used for the old stock block which it replaced. Experiments carried on proved most conclusively that in obtaining a mechanical bond no more concrete was used than could be easily justified by the power with which it gripped the tile core in place, and that the amount and position of this bond could be readily controlled with molding sand. It is by just such combinations of theory, luck and observations that most of the advances in the science of concrete have been made.

⁴P. 288, CONCRETE-CEMENT AGE, June, 1913

⁵P. 213, CONCRETE-CEMENT AGE, May, 1913

Unusual Features in Residence Construction Made Possible by Use of Concrete

By C. O. SPRENGER



FIG. 1—A ONE-STORY REINFORCED CONCRETE RESIDENCE IN LOS CERRITOS, CAL.

Living room walls plainly indicative of the material used,—a fireplace in the middle of the living room, an open bon-fire,—a garden patio in the interior of the house—these are some of the features of the home yhouse described in the following paragraphs.

As an evidence of the advanced steps in architecture in Southern California, developed through the comingling of architectural minds from all over the world, their thought and genius inspired by their new environment, there is herewith presented a description of one of the show places in that part of the U. S. It is the home of Ridley F. Taylor recently completed at Los Cerritos, a suburb of Long Beach, lying at an elevation that gives an unobstructed view of the Pacific to the south and west and the Sierra Madre range to the north and east.

Being convinced that reinforced concrete made the most lasting structure, that its composition met the climatic conditions of a seacoast home-site, especially in this part of the country, Mr. Taylor has had his home built of that material; and this, in conjunction with glass, forms the bulk of the construction.

The walls, partitions, beams in the ceilings, the roof, floors throughout, the bathing pool (instead of bathtub), the pergola columns and beams,

the low wall surrounding the property, the garage, and even the chicken coop—all are of reinforced concrete.

The prime ideas in this 10-room home are perfect sanitation, as much sunshine as possible, as little artificial heat as possible and the sav-

ing of as many steps as possible in the care of it. With these ends in view the following innovations have been introduced:

ADJUSTABLE FIREPLACE HOOD

In the main living-room, about 20'x20', the heat (necessary only



FIG. 2—A CORNER OF THE DINING-ROOM IN A CONCRETE RESIDENCE IN SOUTHERN CALIFORNIA

Details of interest here are the panels in the bottoms of the reinforced concrete beams, the simple line of the fireplace, and the mural decorations



FIG. 3—THE LIVING-ROOM IN A CONCRETE RESIDENCE

The room is heated by a brazier with an adjustable hood. The ceiling and the walls show the monolithic concrete surface

during exceptionally wet weather in the winter season) is derived from a brazier set in the center of the floor; its combined hood and flue of hammered brass is pulled down completely over the fuel basin until the coals are well fired, then it is telescoped up through the roof.

The beams in this room, as in the others, were cast in forms built of rough Oregon pine, specially selected for the beauty and pronounced lines of the grain, and these images have been perfectly impressed. All wall forms were surfaced, consequently very little plaster dressing was required.

The family bedrooms and nursery are all on one side of the house and all connecting; a large guest room on the rear end; dining-room, kitchen, a separate pantry, refrigerator, store-rooms and the bathing pool on the other side.

All the rooms surround and open onto a patio 16'x36' with arched roof covered with glass. In this patio are concrete flower boxes and foun-



FIG. 4—A REINFORCED CONCRETE HOUSE AT LOS CERRITOS, SOUTHERN CALIFORNIA, IS BUILT AROUND A PATIO

This view shows the glass-roofed patio, the concrete garden furniture, etc.

tain. It permits of sunshine in every room, even on the north side, and also gives daylight on two sides of every room and on three sides of the living-room and the dining-room.

Between the broad front porch and the patio is the conservatory with arched roof of colored glass. Open at each end, this is used as the passage way between the living-room and the dining-room. Another passage way between the patio and the guest room connects the rear side rooms, leads to the pool and also opens into the patio.

Under the rear end is a concrete walled basement, and the joists over this supporting the floors above are also of concrete.

In this house the various rooms are finished in hardwood; all doors and window casings are built flush with the walls, all base corners are curved, and there are no baseboards—thus precluding the lodgment of dust and aiding the sanitary idea very materially.

All electric fixtures and hardware are of hammered copper. Wall paper is also taboo; instead, smooth white and tinted plaster is used up to the plate-rail height, and from here decorations in oil embellish the walls.

"When the upkeep and endurance of a home built of reinforced concrete and planned as this one is considered," says Mr. Taylor. "I believe the cost will be found less than that of the house of usual construction. It is certainly warmer in winter and cooler in summer. Furthermore, it is far more sanitary, and there is a feeling of security from fire and other elements."

Time payments, which make no allowance for skill, are wrong; skill payments, which make no allowance for time, are also wrong. In this lies the whole philosophy of remuneration.

House Built of Concrete Block with Interesting Facing

The accompanying illustrations show a general view and a detailed view of a house at Scarborough-on-Hudson, designed by William C. Holden, architect, built by the Ossining Pressed Stone Co., Ossining, N. Y. The house cost \$15,000, concrete broken ashlar work used for first and second stories cost only \$1,162. Practically everything below the roof plate is of concrete, the trim being of a block with a soft gray resembling natural bluestone, and the ashlar having a mottled color effect resembling pink granite. The foundation is of 12-in. block. The wall on the outside is coated with "Driwal" waterproofing. First and second story walls are of broken ashlar made on a Hobbs² machine. Ten-in. block were used for the first story and 8-in. block for the second story. To produce the effect in this broken ashlar several colors were mixed, although the prevailing tone in the finished block is pink. In mixing the colors for this facing, 2 parts marble dust, 1 part cement and a small amount of red mineral color were thoroughly mixed and the water added. Other colors were mixed in the same way, and then the different mixtures were thrown loosely together in one heap and imperfectly mixed. The result is a mottled effect. White, gray and black special aggregate were used in this color mixture, and these with the crushed marble give considerable life and variety to the whole surface. Corners, sills, lintels, belt course, cornice, columns, balusters and other trim have the color of freshly cut bluestone. Crushed marble was the

principal aggregate. The slate roof is on a frame construction and the floors and non-bearing partitions are also of frame. The walls were furred, lathed and plastered on the inside. Over all bays and extensions in the first story, reinforced concrete roofing was used. The width of the building is 45', while the length, including the 10-ft. porch, is 68'. The first story height is 10', the second 9'. The basement contains large laundry in addition to furnace and storage rooms. The first story has a living room, library, dining room, kitchen; the second story has five bedrooms, sewing room and bath; there are two other bedrooms and bath in the attic, besides considerable storage space.



GARDEN VASE OF CONCRETE

Ornamental Concrete Cast In Sand and Tooled

The garden vase shown in the accompanying illustration was made by the Buffalo Litholite Co., Buffalo, N. Y. All the company's work is cast in sand molds with a wet, especially well graded, light stone mix which is agitated from the time it leaves the mixer until run into the molds. The work is subsequently tooled.



FIG. 1—HOUSE AT SCARBOROUGH-ON-HUDSON BUILT OF SPECIALLY FACED CONCRETE BLOCK



FIG. 2—DETAIL VIEW



FIG. 1.—RESIDENCE OF GEO. B. LINNAARD, RIVERSIDE, CALIFORNIA

Mission architecture executed in native field stone, reinforced concrete, and cement stucco. Arthur B. Benton, archit., Rolf R. Newman, engr. and bldr.

A Review of the Development in the Construction of Concrete Houses—1907 to 1914

BY ROLF R. NEWMAN¹

The date, May 15, 1907, may be taken as the beginning of the ever-growing movement toward the erection of concrete dwelling houses. On that date the Jury of Award made its report of prize winners in the first competition for designs of "Suburban Dwellings in Concrete," conducted by the Assn. of Am. Portland Cement Mfrs. Prior to that date *Concrete*, published in Detroit, and *Cement Age*, then published in N. Y. C., and a few other periodicals, had made interesting suggestions regarding concrete houses but there was no united effort toward a definite goal.

Concrete Engineering had just been started in Cleveland and I quote from its initial number (Jan. 1, 1907)—which I am proud to own—as follows:

The story of cement during the past six years appeals to the imagination as does no other trade in history. * * * One must beware of prophecy, even with mathematical inspiration. The hard, fast code of the engineer business man, not the kiting faith of the promoter, will rule our procedure.

This informed and inspiring, yet wisely conservative, attitude has ruled the concrete house movement during the past seven years and today we find laid in the minds of the people a sure basis of confidence in this material and an amount of experimental data and standardized meth-

ods which needs only *proper extended dissemination* to startle the building world.

These seven years have seen the welding together of *Concrete*, *Cement Age* and *Cement Engineering* into a strong advocate, record and guide of concrete construction, but the "extended dissemination" I have in mind must personally reach every worker in cement in the U. S. (if not in the whole world) and give him a vision and the *methods of achieving it*.

EDUCATIONAL WORK NEEDED

It is the difficulty of disseminating working knowledge of the *best methods* that causes such remarks as: "I know concrete houses are fine—but to whom shall I go to build one for me?" To be sure, in the majority of small cities in America and many large ones—whom would you go to? Smith, the carpenter; Jones, the mason; and Brown, the cement walk artist, "know all about concrete"—but are they ready to build the ideal house our concrete house must be?

Through our periodicals, through the American Concrete Institute, and through Government Reports, as well as from man to man, this information will be spread. Just at present we are caught in a slight swirl at one side of the great general current of concrete construction. The work is great—the craftsmen few. The foundation is sure, the growth satisfac-

tory, the pause but momentary and the coming swift development will be impressive. It is a time to be proud, but to work—not boast.

Part of the work to date has been to establish clearly the merits and limits of concrete block houses and of cement stucco houses so that it would be clear just where the field of monolithic concrete houses begins, and the relation and possible co-operation between them. Only through a so-called "Concrete Block Symposium" appearing as recently as the March, 1913, number of *CONCRETE-CEMENT AGE* has the concrete block matter been brought out so definitely by a series of letters on the subject, that the matter is well in hand for solution. It became very evident as early as 1907 that the concrete block houses then springing up in large numbers could not be boasted of (except by the manufacturers of the machines that made the blocks) and such articles as "Art and Architecture in Concrete Structures"² were wholly devoted to the betterment of concrete block houses.

A writer in the *Canadian Cement and Concrete Review*³ says:

Within the past two or three years there has been a weeding out of incompetent and careless cement block contractors. When cement block or cement brick first began to be used as a building ma-

¹Riverside, Cal.

²*Concrete Engineering*, Jan. 15, 1907

³*Concrete Engineering*, July, 1910

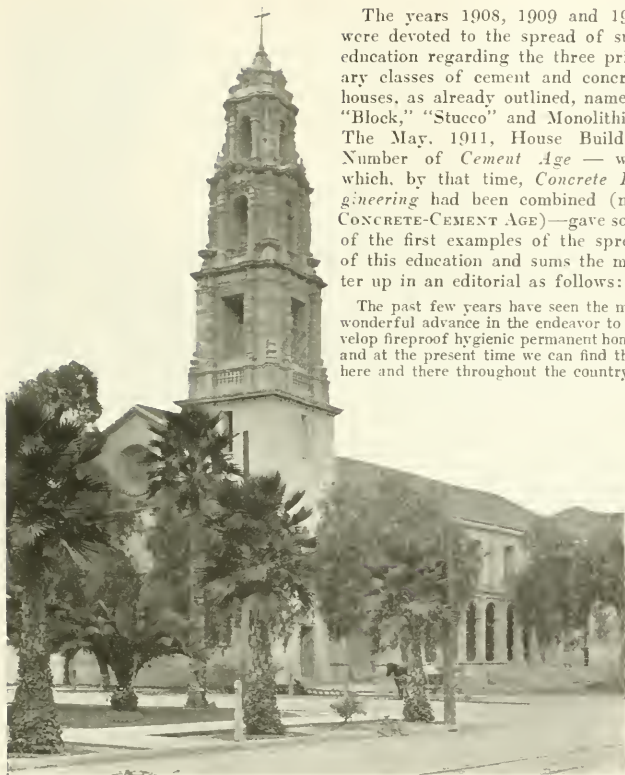


FIG. 2—FIRST CONGREGATIONAL CHURCH, RIVERSIDE, CAL.

Tower is of concrete stone in Spanish Renaissance design. Myron Hunt, archit., Cresmer Mfg. Co., contractors, Rolf R. Newman, supt. in charge of construction

terial many men without any other apparent vocation entered into the concrete business and built up what might be termed a square box, or rectangular affair which they called a house, and which they asked some local carpenter to put a roof on.

Concrete houses have at times approached dangerously near this same "square box or rectangular" pitfall. While the "weeding out" process was still going on *Concrete Engineering* (May, 1908) had the following to say:

We predict that every maker of concrete blocks who does not learn to turn out a block the tests of which will satisfy the most exacting architect, builder or owner in regard to dryness and strength, will find his occupation gone within four years.

One other quotation from *Concrete Engineering* (Nov., 1909) has an especial bearing on the spread of proper information regarding all branches of cement and concrete house construction. It is that:

The rise of any industry is measured by the education of the men of that industry, the men who are that industry.

April, 1914

The years 1908, 1909 and 1910 were devoted to the spread of such education regarding the three primary classes of cement and concrete houses, as already outlined, namely: "Block," "Stucco" and "Monolithic." The May, 1911, House Building Number of *Cement Age*—with which, by that time, *Concrete Engineering* had been combined (now CONCRETE-CEMENT AGE)—gave some of the first examples of the spread of this education and sums the matter up in an editorial as follows:

The past few years have seen the most wonderful advance in the endeavor to develop fireproof hygienic permanent homes, and at the present time we can find them here and there throughout the country.

approached the matter from other fields of experience in which they have used cement. Architects and builders are as a rule more bound by precedent in the matter of building materials—more closely related to and allied with the *existing building trades*—than engineers. For this reason the concrete house today is more a product of engineering than it is of architecture. For complete success it must, however, become both architecturally and structurally correct. The May, 1912, House Building Number of *Cement Age* illustrated more fully than had ever appeared before the results of actual co-operation between architects and engineers. In 1913 more descriptions began to appear of isolated concrete houses as well as groups or communities of concrete homes so that today, at the beginning of 1914, there lies before us an ever-widening field of endeavor. Without knowing the contents of this present House Building Number I feel certain that it fully justifies my statement in 1912 that "the next two years will see more concrete houses built than have been erected in the past two decades." My forecast at that time as to our five-year growth yet remains to be verified.

To sum up the present situation, it is that architects and engineers have at last "got together" on the concrete house problem. We are fully equipped to defend concrete houses from unjust attacks by competing building material interests. Not to omit entirely concrete tile I would class it structurally with concrete block and maintain my three principal divisions of cement and concrete houses, namely: "Block," "Stucco" and "Monolithic." I have recently come in close supervisory contact with all three, not to mention also "Wood," "Brick" and "Stone," but through it all I observe a gradual increase in the amount of concrete used, even though other materials are still adhered to for certain details.

I take pleasure in forwarding for presentation with this review, three views³ of concrete structures in the comparatively small city of Riverside, Cal. The first view is of a large country residence, the first story of which is of concrete faced with native stone, the stories above of cement stucco on metal lath. The second view is of the recently completed Congregational Church, the tower of which is a most excellent example of concrete stone work. The third

We are still "endeavoring," but a comparison between the \$2,600 concrete cottage appearing on the cover of the 1911 House Building Number of *Cement Age* and the \$26,000 concrete mansion appearing in the Mar., 1913, Building Number of CONCRETE-CEMENT AGE shows a rise in the field of endeavor and application. This comparison also illustrates my point made in a previous review of this subject—that the principles are the same from a \$300 concrete gate house to a \$1,000,000 concrete factory or office building, and that the successful execution of work between these limits is entirely a matter of *correct methods and proper organization*.

THE CONCRETE HOUSE A PRODUCT OF ENGINEERING

It is undoubtedly a fact that engineers have done more than architects in establishing "correct methods" and assisting in the "proper organization" of such work as applied to house construction, because they have

¹*Cement Age*, May, 1912

³Illustrations are from photographs by Brown, Riverside, Cal.



FIG. 3—FRONT COURTYARD OF GLENWOOD MISSION INN, RIVERSIDE, CAL.

The original construction in adobe, extended in wood, brick, stucco, and lastly in reinforced concrete. Arthur B. Benton and Myron Hunt, archts., Rolf R. Newman, engr., G. Stanley Wilson, supt.

is a view in the courtyard of the Glenwood Mission Inn, which is at present being enlarged by the construction of a \$100,000 extension in reinforced concrete. The two latter buildings, together with a recently completed Federal Building (also including much concrete work), a Public Library and certain business blocks constitute a Civic Center which in its construction has required the use of a great deal of cement. Between such civic uses (which in a larger city would also include concrete office buildings) and the great structural uses in more isolated locations (greatest of which is the Panama Canal) concrete for residence purposes holds a *middle ground* of large extent and as yet but slightly developed. Other time honored materials are fast relinquishing first place, structurally speaking, and are assimilating themselves as important accessories to the ideal building material—concrete.

The appearance of a new tool usually brings with it the question, "Why did we not use this in the first place and save all the expense of the old tools?" When comparing old

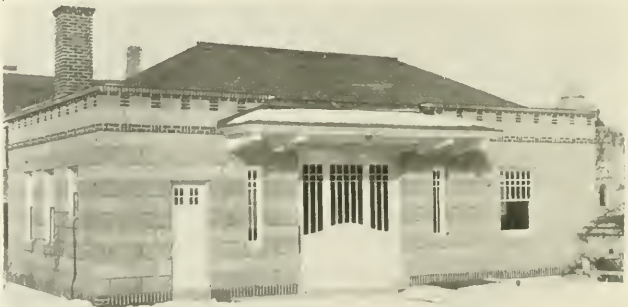
and new methods of manufacture and the cost, it does seem absurd, that the "old way" was ever in use; but on considering the question carefully we come to the conclusion that the "old way" has been the means of producing the "new."

Two Tones of Granite-Faced Block in Garage Wall

The garage shown in the accompanying illustration was built by

Sturtevant and Hook, New Bedford, Mass., for John G. Nicholson, with N. C. Smith as architect. The concrete block are 12" x 24" x 8", made on a Hobbs' machine. The block are granite-faced in two tones—one dark granite and ordinary gray cement and the other a mixture of light granite and white cement. The faces of the block were sprayed. The walls were laid up by the block manufacturers and the result, with the brick trim, is very attractive.

Hobbs Concrete Machinery Co., Detroit



CONCRETE BLOCK GARAGE, NEW BEDFORD, MASS.

Architectural Possibilities In Concrete—Particular Reference to Stucco

By P. P. COMOLI¹



FIG. 1—RESIDENCE OF P. P. COMOLI, SIOUX CITY, IA., SHOWING DECORATIVE POSSIBILITIES IN HIS METHODS OF SURFACE TREATMENT

This house was built a dozen years ago and has reinforced concrete floors. The porch columns and beams are monolithic and the effect of joints was obtained in the surface coat of stucco. The house number was put on in the same way

Since this paper by Mr. Comoli was read to the members of the Iowa Assn. of Cement Users, the author made it much more valuable to readers of this magazine by writing further details of his methods of handling stucco to get the various tones shown in the illustrations while using but one mixture of cement and aggregate.

The ordinary concrete structure, whether of building blocks, reinforced concrete or monolithic masonry, and commonly finished for exposure to view, is often not pleasing in appearance. And this fact seems to be the principal reason for the disfavor with which some architects and engineers regard concrete as a material for building construction. There is, therefore, an active demand for a means of putting a better front upon concrete without overloading it in cost.

It is to be regretted that the average cement user knows so little, and cares less, concerning its development. The time is not far distant when a cement worker must learn his trade, the same as is required in

any other profession, in order to create a demand for his line of work in competition with the old order of construction, and create a progressive tendency in the real art of using this splendid plastic material.

Concrete workers may be put in four classes:

First: The men engaged in producing rough or common concrete work, as foundations for buildings, piers, dams, abutments, bridges and structural concrete for buildings. These men do not require a great deal of practical experience—only a well prepared set of specifications and plans to work by.

Second: Builders of sidewalks, floors, pavements, steps, curbing and gutters, and such other works that come up to their experience. These men must have some practical experience to be able to get satisfactory results, in workmanship and durability.

Third: Manufacturers of artificial stone, building blocks, drain tile or anything which is made with form or mold. These men also must know the requirements as to proportion, the right kind of aggregates, and the right treatment to cure their product properly.

Fourth: The artisans who are called upon to do surface work, such

as on concrete bodies, brick and stone walls, and other surfaces that require a face or exterior finish and ornamental work of art in architecture. These men must have all the necessary knowledge belonging to this class of work. First of all, an artisan fitted to do this class of work must have some mechanical skill, and a thorough knowledge of the chemical action of the cement when it is



FIG. 2—OTHER EXAMPLES OF SURFACE TREATMENT BY MR. COMOLI, THE TWO TONES OBTAINED FROM BUT ONE MIXTURE

¹Sioux City, Ia.

mixed with its proper aggregates, suitable for the work on hand, to enable him to produce the desired surface shape, shade or colors, without injury to the physical strength of the cement while in a stage of hardening; because cement when it is mixed with water becomes a living substance and hardening takes place.

Cement plaster can be applied successfully to any walls or to surfaces made of any material, provided special precautions are taken in preparing the surface, so that the plaster will adhere and not crack or scale off.

If a brick or stone wall has been laid up with lime mortar, it is necessary that the joints be raked out to the depth of $1\frac{1}{2}$ ". Then clean the surface thoroughly by using plenty of clean water, so as to soak the wall.

As a rule two coats are used for a plain surface; but if a more artistic effect is desired three coats are necessary. The first is a scratch coat, composed of 2 parts of clean sand to 1 part of cement, with about 10% or 15% of hydrated lime. If slaked lime is used it must be used in a liquid form. The thickness of this coat should be about $3\frac{3}{4}$ " to $1\frac{1}{2}$ " and should be left rough.

Care must be exercised in applying the second or last coat, to see that the mortar in the previous coat has reached the same degree of setting or has the same suction over the particular wall area that is to be finished, as this precaution is necessary to insure the desired uniform shade in the last coat.

If Tyrolean rustic (rough coat) be desired as a final finish, it is necessary to treat the second coat accordingly, with the proper tooling to indicate the margins at corner, window sills, caps, water tables, belt courses, panels, and whatever trim may be desired. This, of course,

must be done at least one day before the rough coat is applied.

ROUGH CASTING

In rough casting, start at the upper corner of the building by wetting the wall thoroughly. In the meantime the helper mixes the cement in the proportion of 1 part of cement to 1 part of sand. This mixture should be taken to the place where it is to be used, and then wetted in a small box to the consistency of thick cream as needed, being kept well agitated.

This mixture must be put on with a broom made of fine twigs. Standing about 2' from the wall the broom is dipped in the mortar and struck on a round piece of wood held in the other hand. This allows the mortar to reach the wall in a spraying fashion like raindrops. Repeat this by going backward and forward until the surface comes out in a rough form like a chinchilla cloth surface, and until it has come to the desired color. At this stage it is possible to make several shades or colors from the same mixture, wherever you intend to have them, as a contrast. To obtain a lighter shade at desired place put on more water with a brush, and then continue the same operation as before. With this process you will find a distinct color from the rest, in the next day or so, provided the atmospheric conditions are suitable.

After an hour or so, according to the weather conditions, proceed to clean off the parts intended to have this lighter color by using a prepared piece of wood lath, rubbing off the roughest from the trimming, and brushing off with a dry hair brush. These places will turn white when the surface becomes dry. And as soon as it will stand water, keep it wet by putting on clean water uniformly.

Another surface which is very pleasing and not costly to produce

can be done with two-coat work. When the last coat is put on and brought to an even surface, either with a steel trowel or with a wooden float, make out the desired design—the parts you wish to have different from the other. After an hour or two, according to weather conditions, scrape the surface and remove the crust or smooth surface by using a small pointing trowel. You will get the two distinct colors the same as in rough cast finish. There are made other surfaces that can be produced with attractive finishes, but all the work of this nature has to be learned by experiment. Its possibilities can only be suggested in a written description.

If it is not properly handled, faulty work may result, as is often the case when failures occur in cement work, due to ignorance or carelessness at this stage of the process. It is possible to produce as many as four or five distinct shades or colors from the same mixture by giving the necessary treatment, or tooling at the proper stage of hardening, and with the favorable atmospheric conditions of the day the work is performed, cement being very sensitive when exposed to the elements of the weather. Cement in itself is not a finished product, but is only a binder to mix with other aggregates suited for the purpose. Therefore it is very important that a cement worker in this class of work should learn the trade by practical training—not only from books—in order that cement or concrete work shall have a well deserved place in architecture.

CEMENT IN ARCHITECTURE

Cement in architecture has played a prominent part in various ways for centuries. It has been used for great resisting strength, for fireproofing qualities, and found well suited for exterior ornamentation for new and old structures.



FIG. 3—TWO MODEST STUCCO COTTAGES SHOWING SURFACES IN TWO TONES—DESCRIBED AS AN ECONOMICAL ORNAMENTAL TREATMENT

In its adoption is found a medium yielding to any scheme in color or design; especially for residences it conveys primarily the impression of strength and durability.

If our designers will devote themselves with sufficient energy to the demands of this new material, as it so well deserves, they will discover a new architecture that will be full of life, character and dignity—which will go to making up a living style.

It is not sufficient because we have succeeded in manufacturing good artificial stones, durable cement blocks, good sidewalks, cement floors, good foundations for great buildings, or that we have succeeded in making cement stick to a brick wall. We must know how to do the best that has ever been made and become skilled in its use. When there has grown up a great intelligent army of artisans skilled in the proper uses of concrete and cement, when we discard the notion that any common laborer is good enough to do the work, we shall have reached a point where we will not be satisfied with anything less than the full and complete expression of our material in architecture.

The writer is in sympathy with the architect, the engineer and the designer, their work having suffered in many instances from their inability to get skilled workmen to carry out their ideas, as expressed in their designs. If their work turned out successful it was the pride of the designer. If not it was his disgrace—just because the other fellow—the workman—didn't know any better.

On the other hand, designers are somewhat to blame for not co-operating with practical workmen, as to the practicability of their ideas, before the completion of their plans, and having a thorough understanding of the task to be undertaken, in order to simplify the work and minimize the cost and obtain the desired result with the least effort.

For these reasons designers and practical cement workers should co-operate more and obtain the information best suited to carry out the architectural possibilities with cement, it being the best building material in existence for all purposes.

The writer's recommendation, for the benefit of him who is inclined to take up this useful profession of cement construction, which as yet is only in its infancy in this country, would be that he should perfect himself for the business through practical demonstration, assisted by such a knowledge as he may acquire with those who may have had experience.

Large Ornamental Jars Modeled In Concrete: In Two Pieces

By CHARLES T. SCOTT¹

In connection with a rather large assortment of ornamental concrete work which was illustrated in the Feb., 1914, issue, there was a discussion of certain features of design and of execution—particularly in the control of the surface texture—which are important in the manufacture of such ornamental concrete objects. The objects illustrated and discussed were made in plaster molds, produced on clay models, which had been turned to shape by using a revolving template with a sheet iron edge mounted on a wooden frame. In casting the products no core was used, the plaster mold being set right side up and the concrete put into the mold and pressed into position against the plaster sides with the hands, working on the inside of the plaster mold. The work is cured by using a great deal of moisture subsequent to placing the concrete. In the article presented here Mr. Scott describes the making of very large jars—about 8 ft. high—by a very interesting method without the use of a plaster mold.

Owing to the shape of the jar shown in Fig. 1, it was made in two pieces, which were subsequently jointed with rich mortar on the line of the jar's greatest circumference, the joint being hidden by the belt of mosaic.

The jars were made on a low, strong stand with a smooth, heavy top. A piece of $\frac{1}{2}$ -in. pipe was dropped through a $\frac{9}{16}$ -in. hole in the center of the top of the stand and sunk into a hole of the same size bored part way through a cross-piece which was nailed across the bottom supports of the stand. This gave a steady center rod on which to revolve a template and it was at the same time easily lifted out.

A full size drawing of the vase was made and a line traced within the outline to mark the thickness of the vase. This inner line was used as a pattern to cut the wooden template to form a clay core for the inside of the vase. The vase being



FIG. 1—A CONCRETE JAR MADE IN TWO PIECES

in two pieces, the template was divided and but half the work done at a time. This template had a cross-piece halved and screwed across the top to reach the center rod. A couple of sheet iron loops were bent around the ends of this cross-piece so as to enclose the rod and form a bearing when the template was revolved. These bearings were fastened on with stove bolts. Notched into the bottom of the template was a short piece of $\frac{7}{8}$ -in. wood beveled up at the ends. This raised the bottom of the template about $\frac{1}{4}$ in. and acted as a runner to make it revolve smoothly.

A bunch of damp newspapers was tied around the rod and soft clay piled around them, the template being revolved as needed to form the round core. The clay was allowed to dry until tough, the surface roughened, and then given a couple of coats of shellac.

The template, readjusted so as to describe the outer rather than the inner outline of the work, was then furnished with a zinc facing cut exactly to the final outline of the vase. This was tacked on so as to extend $\frac{1}{4}$ " over the inside edge of the wood, which was beveled away from the

¹Instructor in Modeling Dept., School of Industrial Art, Philadelphia

Some Practical Suggestions on Concrete House Building from a Builder

The following notes, arranged from a recent letter received from P. H. Bosworth, an architect and builder of San Francisco, embody a few suggestions on the problems of house design and construction. While every job is in a way a special problem, there are underlying conditions generally common to all work. The conditions are touched upon briefly in the following paragraphs:

WALL THICKNESS AND HOLLOW WALLS

In regard to thickness of concrete walls in house construction, 6" is plenty for any size residence, providing the foundations are good and the rooms not too large. One essential for an all concrete building is a hollow wall. This is necessary for a number of reasons, first among them being that an air space in the walls and ceilings takes away to a great extent the reverberation or echo that always occurs in a solid concrete room. This echo is unpleasant, giving the room a cave- or tomb-like feeling. Some people imagine they are in prison or underground and this gives the enemies of concrete a peg to hang an argument on.

All this can be obviated very easily by making a hollow wall. One way of doing this is by setting in metal linings which stay in and form an air space. These linings can be manufactured by any sheet metal works that have a stamp, and will cost in San Francisco about 10 cts. per sq. ft. of wall surface where needed. They resemble two light pans pressed out of sheet steel—stove pipe iron can be used—placed face

to face with the edges meeting. These linings form an air space for a 6-in. wall, 21 1/2" across by 21" long, and can be run any height desired, as the linings are sectioned and come in pieces about 2' x 2'.

DETAILS OF FINISHING

There is no reason to fur the inside walls at all, although all walls should be plastered to make a first-class job. No concrete work has ever yet been put up for residence work, or any good building work, that could be left without plastering on completion, although we are gradually acquiring cheaper and better methods of finishing. Good outside plastering can be done with one coat where the walls are fairly smooth; inside plastering can be done on the putty coat over plaster bond, but the walls must be absolutely straight and true or the excessive amount of the fine stuff used more than offsets the saving of the brown coat.

ROUGH-CAST OVER PLASTER BOND

As a cheap finish for the outside and one that will keep out moisture as well, the following is suggested: After the interior coats have been applied and the building has had opportunity to dry thoroughly, apply from the outside two coats of some good plaster bond at not more than two days' interval. While the waterproofing is still "tacky," rough-cast the exterior with a 1:2 mixture of cement and coarse sand applied with a paddle. The waterproofing is worth from 15 cts. to 20 cts. per yd. for two coats and the rough-casting is not worth over 25 cts. per yd., making a cost of from 40 cts. to 45 cts. per yd. for an outside waterproof rough-cast job. This done the old way would be worth fully \$1.00 per yd. flat measure, or more.

The building should be allowed to dry thoroughly before being waterproofed from the outside in order that no dampness may be confined in the walls. Concrete dries slowly, depending on the thickness of the wall and the dryness of the atmosphere. After the moisture is all driven out and the building, with hollow walls and floors, is thoroughly waterproofed from the outside as well as from the inside, it is the driest, warmest, strongest, finest building in the world. But it must be built right.



FIG. 2—GARDEN VASES OF CONCRETE

zine on the back. The template was put in place and the clay core given a rubbing with a greasy brush.

A stiff cement mortar composed of 1 part cement to 2 parts of sand was then plastered on the core until coated all over. When this had hardened enough to be slightly absorbent the coating was built out and shaped by the template. When finished, the template was removed by taking out the stove bolts and releasing it from the rod.

The work was covered with oil-cloth and, after several hours, sprinkled with water. This was kept up for three or four days.

Then the center rod was pulled out and the whole form inverted and placed on the floor. The paper was pulled out and the still moist clay pulled away from the inside of the jar.

The two parts of the jar were made in the same way. A projection on the bottom of the template made a depression around each part of the jar in which the band was set. The stones were set in soft mortar after the vase was dry. A bottom was plastered in and the vase was completed.

We need copies of CONCRETE-CEMENT AGE of April, 1913. If you have good copies please write—Concrete-Cement Age Publishing Co., Detroit.



FIG. 3—SEAT END, MODELED IN CLAY AND MOULDED IN CONCRETE

WATERPROOFING NECESSARY

Many people put up brick and concrete buildings knowing the material to be extremely absorbent, and when the building leaks look shocked as though someone had handed them something. They figure that some special dispensation of Providence should have looked after their buildings, when they are too careless or ignorant to look after it themselves.

Concrete, is to some extent, porous; the walls may be furred or they can be plastered, but in either case they should be waterproofed both inside and outside.

If walls are furred without waterproofing, the moisture and dampness are there, breeding sickness and disease, but they are not seen. It costs more money to fur out walls than it does to waterproof properly and is in the light of present day building and sanitary methods really hiding an evil instead of correcting it. There is nothing to do but to waterproof.

ROOF REQUIREMENTS

The roof can be absolutely flat if made light, but to make a light roof takes more than one coat of asphaltum. If the roof is to be walked on it needs a mastic; tiles may be too expensive. If the roof is not to be walked on, a regular 4-ply tar and gravel roof will do. If asphaltum is used alone, two heavy coats are suggested, both coats graveled, all loose gravel to be brushed off the first coat.

FLOOR SLEEPERS ON EDGE

The floor should be laid on 2-in. x 4-in. sleepers on edge; the 4-in. air space raises the floor surface above the concrete slab, allows a circulation of air, provides room to run gas and electric pipes, etc., and gives an opportunity of placing heating coils in the floor where they belong, as the warmth will rise through the floor, making a very even temperature in the room.

The forms should be removed from the inside walls as soon as possible. If the wall forms are rigid and they stay in until the concrete begins to shrink, cracks are bound to appear in the walls.

The Secretary of the Interior has awarded contract to the Lehigh Portland Cement Co. for 13,000 bbls. of Portland cement at \$1.00 per bbl. f. o. b. cars Mason City, Ia. This cement is for use on the Ft. Peck irrigation project and on the distribution system of the Milk river project, Mont.



ASBESTOS STUCCO ON FRAME—BUNGALOW OF WILLIAM BARNES, ALBANY; MARCUS T. REYNOLDS, ARCHITECT

Albany, New York, Bungalow With Interesting Stucco

The accompanying illustrations show a bungalow built for William Barnes, Jr., Albany, N. Y., Marcus T. Reynolds, archt. It is of panel construction, metal lath, and stucco made with pulverized fibre rock asbestic,¹ in which the fibre acts as a binder and the rock in place of sand. The material was mixed 1 part cement, 2 parts asbestic, using 350 lbs. to 400 lbs. of rock lime with 1 ton of the rough asbestic. It was applied in two coats. The first was allowed to set but while still damp the second coat was applied. The surface was given by using a brush of twigs. The cost was about one-third more than for ordinary stucco and was used because of a lack of suitable stucco sand in the vicinity of the

work. The house cost about \$15,000, a large investment being in special interior woods and special brick for the chimney.

Building Heights

In the following cities, the maximum heights of buildings allowed by ordinance are as follows:

	Feet
Baltimore	175
Boston	125
Charleston, S. C.	125
Chicago	200
Cleveland, O.	200
Erie, Pa.	200
Fort Wayne, Ind.	200
Indianapolis, Ind.	200
Los Angeles, Cal.	150
Manchester, N. H.	125
Milwaukee, Wis.	225
Newark, N. J.	200
Portland, Ore.	160
Providence, R. I.	120
Salt Lake City.	125
Seranton, Pa.	125
Worcester, Mass.	125

¹H. W. Johns-Manville Co.

The Use of Sand-Cast Concrete Veneer Slabs in Louisville Residence

The house shown in detail and in a general view in Figs. 1 and 2 is veneered with 4-in. slabs of limestone concrete cast in sand molds. The house was built about seven years ago and the photographs, from which the illustrations were made, were taken about two months ago. As will be seen, the walls have retained a light uniform tone.

The house was designed by Mason Maury, and built for Harry R. Whiteside, on a site overlooking Cherokee park, Louisville. The concrete veneer slabs are made of a mixture composed of about 1 part of cement to 4 parts of crushed limestone, using all of the stone that would pass through a $\frac{3}{4}$ -in. ring, and no sand, the dust being enough to make a dense stone. Mr. Maury found that this mixture produced a concrete harder than Bedford stone, of good texture, and tooling to a handsome finish. It retained its color, and was cheaper than Bedford stone.

The first house in which Mr. Maury used concrete in this way was a residence for Mr. Whiteside. The slabs or blocks used were cast in sand on the job, about 4" thick and ranging from 15" to 2' in length and width. Absolute uniformity was not desired or attempted, except in the matter of thickness. Slabs were made large and afterward cut up.

The block were allowed to cure for about two weeks, as a rule, and at the end of that time were roughly tooled by a stone-cutter. Construction methods were in other respects the same as in building a house of brick veneer, spikes being used at intervals to bind the veneer wall to the frame.

These block were used for the entire house, including the porch and steps. The porch columns were the sole exceptions, these being L-shaped monoliths of the same mixture of concrete, each arm of the L being 4' in length, outside, and 10" thick. The wooden forms used in casting these columns were lined with paraffin paper to prevent sticking.

The foundation of the Whiteside house is of two walls of rough-cut stone. Between the two stone walls, front and back, the space was filled with an ordinary 1:2:4 concrete mixture, mixed with a waterproofing material; and it has proved absolutely

tight, against the unusually heavy flow of surface and other water down

the rather steep hill on the side of which the house is located.

The striking thing about this work is that such good material should have been used only as a veneer instead of as a structural part of the wall. It is said in connection with this work that the contractor in this case lost money on the manufactured stone.



FIG. 1—DETAIL VIEW OF SAND CAST, LIMESTONE CONCRETE TOOLED; RESIDENCE OF HARRY R. WHITESIDE, LOUISVILLE, MASON MAURY, ARCHITECT

FIG. 2—WHITESIDE RESIDENCE, LOUISVILLE

The Use of Paint Films as Protective Coatings for Concrete

E. E. WARE¹ AND S. M. SCHOTT²

The following paper is more than a report on various concrete coating materials available. It is a searching inquiry into and a discussion of the underlying principles of successfully coating concrete surfaces. It is a plainly stated, concise consideration of an everyday problem in concrete work.

The extensive use of concrete as a building material for all types of construction has naturally been accompanied by numerous failures of greater or less importance. These failures have been seized upon by manufacturers of competitive material and have been brought to the attention of the public through wide publicity, causing a doubt to arise in some minds as to the permanence of concrete construction. However, with the better understanding of the possibilities and the limitations of this material, it has been possible very

nearly to eliminate the causes of failure that were mainly responsible for the difficulties experienced by the pioneers in the use of concrete construction.

CHANGES IN VOLUME OF CONCRETE DUE TO MOISTURE

But we are confronted by a cause of disintegration still less appreciated by the concrete engineer—lack of constancy of volume in concrete after setting. Although the tendency to failure from this cause is more apparent in stucco and other light construction, where mixtures rich in cement are used, monolithic work is by no means free from the effects of this lack of constancy of volume, and we find failure cracks, the presence of which can be accounted for only by the assumption of a differential expansion in the different members of the structure.

Prof. A. H. White³ has shown⁴ that the changes in volume due to changes in temperature are small as compared to the changes due to the alternate wetting and drying of the concrete,

and that these latter changes are sufficient to cause failure in many cases.

Another source of trouble, in which water plays a part, is the electrolytic effect of stray currents on the steel reinforcement in concrete. This corrosion of the reinforcement could not take place in perfectly dry concrete.⁵ The elimination of these two causes of disintegration in concrete is strictly a problem in waterproofing.

Waterproofing materials for use with concrete are divided into four general classes; membrane, integral, surface washes, and oil paint films.

The U. S. Bur. of Standards has made an extensive study of waterproofing materials, and its report⁶ on this subject by Rudolph J. Wig and P. H. Bates, seems to show that none of the integral or wash waterproofings are efficient in preventing the absorption of moisture, although they may prevent the percolation of water through the concrete.

Recent work⁷ seems to have demonstrated that volume changes are caused by adsorbed water, and that the presence of waterproofing within the concrete has very little effect upon the ultimate percentage change, and that its only effect is to retard the rate of absorption.

¹Asst. Prof. Chem. Engrg., Univ. of Mich., Ann Arbor, Mich.

²Holder of Paint Fellowship, Acme White Lead and Color Works, 1911-1912, Univ. of Mich., Ann Arbor, Mich.

³Univ. of Mich., Ann Arbor, Mich.

⁴Proc., Am. Soc. for Test. Mat., 1911

⁵Rohland—Wasser u. Abwasser, Vol. 5, p. 504. O. Berndt—Beton u. Eisen, Vol. 11, 1st Supplement. C. de Wyrall—Proc., Int. Assn. for Test. Mat., 1912, p. 20.

⁶Bur. of Standards, Technologic Paper No. 3

⁷Prof. A. H. White—Private Communication; Jesser—Tonind, Zeitung, Vol. 37, pp. 535-538

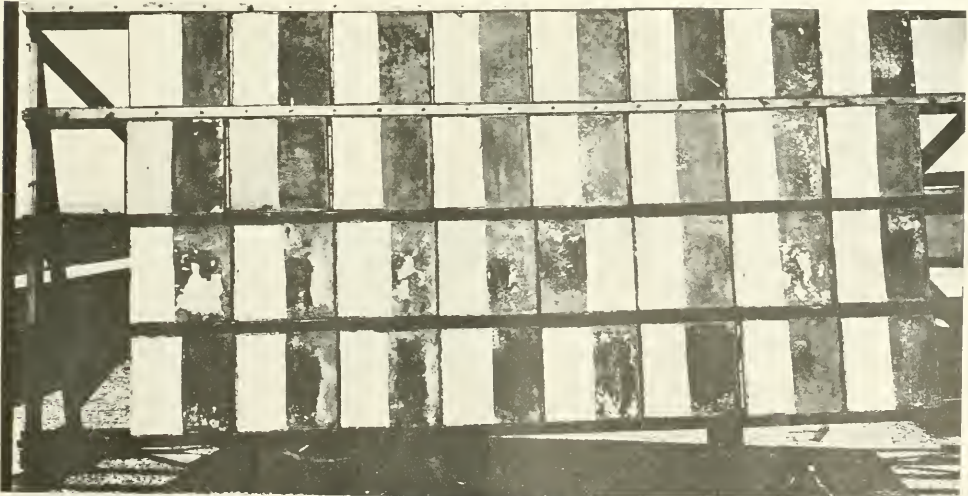


FIG. 1—RACK ON THE ROOF OF THE CHEMICAL LABORATORY, UNIV. OF MICH., CARRYING 32 PANELS, TESTING 16 DIFFERENT CONCRETE COATING MATERIALS

The right half of each panel is coated with a green paint which is used to indicate the presence of lime



FIG. 2—PANELS 1 AND 9, TYPE 4

The use of an impermeable membrane on the exposed side of the concrete would very efficiently prevent the passage of water to the concrete, and would, therefore, prevent the resultant disintegration due to either moisture volume changes or to electrolysis. However, in the majority of cases it is not feasible to use an asphalt felt membrane, so we are limited to the use of the somewhat less efficient but more suitable paint film.

REQUIREMENTS FOR CONCRETE COATINGS

Without doubt, paint films can be compounded that will be practically impervious to water; but they must, in the case of concrete coatings, be also able to stand the saponifying action of lime leached out from the concrete, as well as be insensitive to the attacks of the weather.

Manufacturers have made attempts to solve the problem of putting out a satisfactory concrete coating; but there has been a decided tendency to lose sight of the fact that first of all the paint must be of such a nature as not to lose its elasticity or impermeability through the influence of the weather. The paint must possess all of the weather-resisting qualities of any paint designed for outside work, in addition to being able to meet the conditions peculiar to this particular service.

TYPES OF CONCRETE COATINGS

Concrete coatings may be classified in general:

- (1) Coatings compounded from materials inert to the action of alkali;
- (2) Coatings the vehicles of which carry considerable amounts of free organic acids;
- (3) Coatings compounded with the idea of getting a hard and perfectly impenetrable surface;
- (4) Those coatings the virtue of which lies mainly in the elastic and only slightly permeable film formed

from the good drying oil which constitutes the major portion of the vehicle.

The first class may contain neutral gum varnishes, petroleum products,

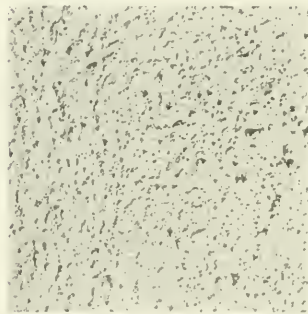


FIG. 3—A DETAIL VIEW OF THE SURFACE OF PANEL 1

may be of a casein base, or may be made up from a cementing pigment.

Experimental data as well as practical experience with paint films for general service work, have established the fact that the vehicle for any paint should be selected with a view to getting the maximum of elasticity

in the dried film, recognizing that any additions that tend to harden the film will, at the same time, increase the brittleness and accelerate the disintegration.

Paints of the second class are quite common and appeal strongly to the average user, inasmuch as the free acid is supposed to serve the double purpose of neutralizing any lime that may be present and at the same time sealing the pores of the concrete with the precipitated lime soap. The free acid of this type of paints is sometimes an added fatty acid, and sometimes the unneutralized resin acid of a varnish mixed with the oil as a constituent of the vehicle.

An English investigator, Cathcart, claims that the soaps used in waterproofing have a disintegrating influence on linocyn. This will apply as well to the insoluble soaps formed in the neutralization of the lime by the free fatty acid of the second type of coating.

In an attempt to determine the extent to which the reactions take place when a coating of this type is applied to a concrete or a stucco surface, some samples of oil were subjected to parallel tests. The oils were as follows:

- No. 1. Raw linseed oil.
- No. 2. The same oil to which had been added a small amount of fatty acid.
- No. 3. The same oil to which had been added 20% of rosin varnish containing a considerable amount of unneutralized rosin acid.

Each of these samples of oil was shaken at intervals for three weeks, with three different pigments, calcium carbonate, calcium hydrate and Portland cement. To each of these was added about 10% of water, and the whole was diluted to double its volume with kerosene. A fourth set

¹Concrete and Const. Eng., Vol. 7, pp. 330-337

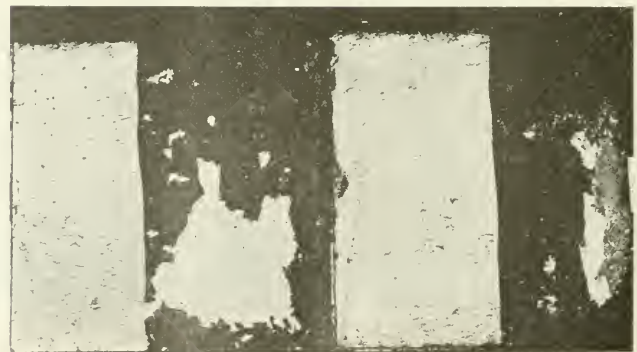


FIG. 4—PANELS 17 AND 18, TYPE 1

TABLE I

	Linseed Oil			Oil and Acid			Oil and Varnish		
	Acid No.	Sapon.	Iodine	Acid	Sapon.	Iodine	Acid	Sapon.	Iodine
Original	1.90	113.9	122.2	9.1	105.5	111.1	6.7	105.4	118.9
Calcium carbonate	1.3	118.4	123.3	7.9	109.9	111.9	6.1	110.8	122.8
Calcium hydrate	0.1	114.1	122.6	0.2	104.7	114.5	1.2	105.5	125.8
Dry cement	1.0	115.6	122.3	4.7	105.0	111.6	2.7	109.4	125.4
Wet cement	.2	114.2	122.6	0.3	105.0	113.2	0.4	103.1	125.6

was shaken with dry Portland cement. The results are tabulated in Table I.

A comparison of the acid numbers of the mixtures in the presence of wet cement and calcium hydrate, shows practically as complete a neutralization of free acid by the cement as by the generally more active calcium hydrate.

The absence of any indication of saponification as shown by the comparative uniformity of the saponification numbers, shows that there is no soap formation by any of the materials of the concrete saponifying the neutral glycerides of the paint coat, so long as they remain in the liquid, unoxidized condition.

The units used in Table I are the regular analytical units in use in oil testing; "acid number," denoting free acid; "saponification number," a measure of material saponifiable by caustic potash; and "iodine absorption number," a measure of the capacity for absorbing oxygen during drying.

The tests on iodine absorption were made as a more or less accurate check on the evaporation of the thinner during shaking and centrifuging.

Assuming the same conditions to hold under actual conditions of service, there will be an action between the acid of the coating and the cement at the surface of the concrete, which will give a film of lime soap at the surface, to which the paint film must cling. This action is all near the surface, for there are present within $1/64''$ of the surface of an ordinary concrete sufficient lime compounds to neutralize all the acid content of the common concrete coating. These coating materials show themselves to be inefficient as neutralizers, and the life of the film cannot be long when they have nothing better with which to bond them than a skin of insoluble soap.

The impenetrable surface of the third type of coatings is generally derived from a gun-hardened film, the vehicle of this coating being

largely varnish. The paints of this class really possess the faults of both the first and the second class, for the resins of the varnishes are at least in part acid, while as a whole the hard film is subject to the same accelerated disintegrating influences as affect any non-elastic film.

OUTLINE OF THE TEST

With an idea of studying the efficiency of the different types of coating materials, a few of the more widely advertised ones were purchased, and together with some made up in the laboratory, were applied to surfaces of concrete and stucco, and given an exposure test that has extended over about two years' time.

The exposure panels were each $18'' \times 18''$ and $2''$ thick, reinforced with expanded metal, and held within a frame built up from $1/4$ -in. x 2-in. steel band, to insure them against breakage. The backs of the panels were covered with galvanized iron in order that there should be no water entering from the back of the panel,

TABLE II—SUMMARY SHOWING CONDITION OF 16 DIFFERENT CONCRETE COATING MATERIALS APPLIED TO 32 PANELS

Coating No.	Panel No.	Amt. Applied (in grams)		Type of Coating Material	Condition 1 yr.	Condition 2 yrs.	Approx. Life	Condition of Green Indicator
		1st Coat	2nd Coat					
1	1	51	64	4	Good	Good	3 yrs.	Gen'l bleaching
1	9	45	43	4	Good	Good	3 yrs.	Gen'l bleaching
2	2	22	39	3	Very poor	Gone	4 mos.	Spotted
2	10	26	36	3	Very poor	Gone	4 mos.	Spotted
3	3	25	43	2	Poor	Very poor	8 mos.	Spotted
3	11	25	42	2	Poor	Very poor	8 mos.	Spotted
4	4	27	43	2	Poor	Very poor	8 mos.	Large spots
4	12	28	38	2	Poor	Very poor	8 mos.	Large spots
5	5	79	68	1	Good	Fair	2 yrs.	Spotted
5	13	78	70	1	Good	Fair	2 yrs.	Spotted
6	6	61	..	1	Very poor	Gone	6 mos.	Not many spots
6	14	52	..	1	Very poor	Gone	6 mos.	Not many spots
7	7	66	37	4	Good	Fair	2 yrs.	Free from spots
7	15	43	36	4	Good	Fair	2 yrs.	Free from spots
8	8	62	62	3	Very poor	Gone	4 mos.	Few spots
8	16	53	67	3	Very poor	Gone	4 mos.	Few spots
9	17	51	60	1	Gone	Gone	3 mos.	Disintegrated
9	18	70	46	1	Gone	Gone	3 mos.	Disintegrated
10	19	55	66	1	Gone	Gone	3 mos.	Disintegrated
10	20	49	59	1	Gone	Gone	3 mos.	Disintegrated
11	21	63	64	1	Gone	Gone	3 mos.	Disintegrated
11	22	48	56	1	Gone	Gone	3 mos.	Disintegrated
12	23	58	50	3	Gone	Gone	3 mos.	No spots
12	24	49	45	3	Gone	Gone	3 mos.	No spots
13	25	30	..	2	Very poor	Gone	6 mos.	Few spots
13	26	25	..	2	Very poor	Gone	6 mos.	Few spots
14	27	27	..	1	Poor	Gone	6 mos.	No spots
14	28	..	..	1	Poor	Gone	6 mos.	No spots
15	29	48	..	2	Fair	Gone	12 mos.	No spots
15	30	37	..	2	Fair	Gone	12 mos.	No spots
16	31	50	..	1	Very poor	Gone	6 mos.	Few spots
16	32	50	..	1	Very poor	Gone	6 mos.	Few spots

and that the conditions should be as nearly as possible the same as those existing in an ordinary structure. The paint films were subject, then, to the saponifying action of such lime only as would leach out with the water that might have passed through the film pores, or through cracks that had developed in such films as were unable to stand the weather. If a paint film be watertight it should be free from the action of lime just so long as it remains in perfect condition; but when it begins to show cracks, then with the access of water to the underlying concrete and its subsequent evaporation from the surface, lime will be brought to the under surface of the film.

In these tests, each paint was assigned to two panels; one made up from a 1:3 mix, using cement and river sand, and one panel of a rich 1:2:5 stucco mix, using lime, cement and river sand, respectively. The panels were made up indoors and allowed to set for three weeks before the paints were applied. During the first two weeks of this time the panels were kept damp; but they were allowed to dry a full week in order that there might not be present in the concrete, when the paint was applied, moisture that would prevent proper penetration of the paint and would give an imperfect bond between the paint film and the concrete surface. The second coat was applied after the first coat had become thoroughly dry, the time intervening varying from 3 das. to 7 das.

EXPOSURE OF TEST PANELS

During the time of exposure, the panels were on the roof of the chemical laboratory, mounted on a frame inclined about 20° from the vertical, with the painted surface of the panel facing south. Fig. 1 shows the complete group of panels with their supporting frame. The frame occupied such a position on the roof of the laboratory as would insure the tests being free from the influence of laboratory fumes.

After having been exposed to the weather for a period of one year, 1/2 the surface of each panel was coated over with a green paint, the pigment in which was a mixture of chrome yellow and Prussian blue. This paint served as a very good indicator of the extent to which lime leached out to the surface, the presence of lime being indicated by a yellow spot. In order not to influence too much the porosity of the underlying film, only one coat of the green was applied. In cases in which the paint on the panel was disintegrated badly, an attempt was made to prepare the sur-

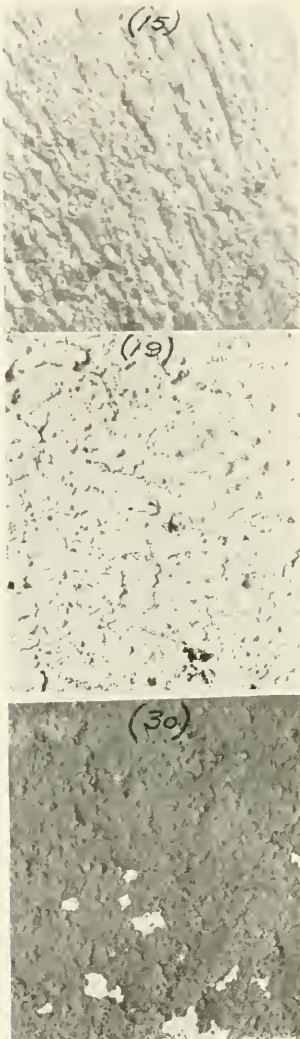


FIG. 5—DETAIL VIEWS OF PANELS 15, 19 AND 30

face for the coat of green paint by brushing off the loosely adhering scales. Even then, in some cases the condition for painting was decidedly unsatisfactory.

A SURFACE FOR REPAINTING ESSENTIAL

This emphasizes the importance of using, in the first place, a paint which, upon disintegration, will present a proper surface for repainting, for it is a well recognized fact that no paint coat can last indefinitely any more on concrete than on wood or metal. Ladd's work¹ has shown this

to be an important consideration in the permanent protection of wooden structures, and the same conditions apply to the protection of concrete.

In Table II is given a summary of the condition of the various panels at the end of two years.

Panels Nos. 3, 11, 4, 12, 25 and 26 were painted with coatings carrying considerable amounts of fatty acid or unneutralized resin acid. The disintegration of these films was early and complete, and was not closely enough characteristic to warrant a classification according to the type of disintegration. The paints for Panels Nos. 3 and 11 carried, in addition to the fatty acid, a small amount of cement as a constituent of the pigment. While the colloidal silica formed in this way may have been efficient in sealing the pores of the concrete, the fatty acid evidently affected the film, the early disintegration of which would not permit these films to be classed as efficient protection for concrete surfaces.

The paints on panels Nos. 6, 14, 17, 18, 19, 20, 21, 22, 31 and 32 depend for their efficiency on the presence of a neutral gum varnish. All of these panels very early exhibited disintegration of the coating. This disintegration was, for the most part, characterized by heavy scaling and flaking, which in some cases left parts of the panel entirely free from paint within a short time.

Coating No. 5, on panels Nos. 5 and 13, was very heavy-bodied and did not spread at all freely. The small amount of vehicle present was neutral in character, the material acting more like a cement than a paint, there being little tendency to form a true paint film. These panels retained their coats fairly well, although they at all times showed a high degree of porosity as indicated by the tendency to absorb any water applied to the surface. This coating might serve well as a decorative paint; but it is probably of comparatively little value as a protection to the concrete surface upon which it may be applied.

The coatings on panels Nos. 27 and 28 help to prove the contention that non-drying oils do not make good substitutes for linseed oil in paints, for they were among the first to show a tendency to disintegrate.

The vehicles of the paints applied to panels Nos. 1, 7, 9 and 15 were made up very largely of drying oil, the content of varnish being small, and the mineral oils being confined to the thinners. These panels were, to all appearances, the most efficiently protected of any in the test. This is true particularly of panels Nos. 1

¹Bulletins of North Dakota Agric. Exp. Stat., Agric. College, N. Dak.

and 9, which were prime-coated with mild process white lead and oil and finished with a special outside white made up of a composite pigment, with the linseed oil vehicle carrying a small amount of varnish as a hardener.

These two panels were subjected to an especially severe test, in that they were exposed at the back during the greater part of the test, the protecting galvanized iron covers having been removed from these particular panels at the end of 3 mos. exposure. This permitted water to get in from the back of the panel, which, had the pores of the concrete not been perfectly sealed, would have caused a decided saponification of the linoloxyn film, for the water would naturally have evaporated from the side of the panel exposed to the sun, and in this evaporation would have deposited considerable lime within the film. Had the lime come to the surface in any quantities it must have saponified the film, as linoloxyn is extremely sensitive to alkali, both sodium hydroxide¹⁰ and calcium hydroxide attacking it in the cold.

SUMMARY OF RESULTS

Assuming water to be an important agent in the disintegration of concrete and stucco, there is a necessity for a system of waterproofing that will prevent absorption. The film coatings most nearly fill such a specification, where the surfaces are to be at all ornamental.

No coating compound can be successful that will disintegrate under the influence of the weather. This eliminates from consideration any material that would not be classed as a good coating material when applied to materials other than concrete.

Although linoloxyn is readily saponifiable in the cold, there is not, under ordinary conditions, enough lime carried out by the small amount of water that may penetrate a paint film in good condition, to cause disintegration of the film. This is emphasized by the fact that the disintegration of the paint film under observation in this work is no more pronounced on a rich lime stucco than on a cement-sand mortar or concrete.

The absence of stains on the green test paint film in the cases of some of the panels the coats of which showed disintegration at the time of application of the green, would indicate that the lime at the surface of the panels had become pretty well carbonated within the first year. Any stucco exposed to the weather for a

year's time can be coated satisfactorily with a good outside paint.

A successful concrete coating material should be compounded on the same basis as is used for a satisfactory outside paint for wood, with only such adjustments in composition as tend to make it more nearly impervious, and these must not be made at the expense of the elasticity and general durability of the film.

The panels of these tests are to be repainted with the original materials, and a further set of experiments is in progress in which measurements of the expansion and the contraction of the individual panels will be made.

Individual Openings in Retaining Walls

Some months ago the street railway in Sebastopol, Cal., made a heavy cut in one of the streets of the town. The city required that a concrete retaining wall should be built by the railway along the one side where the cut was deepest. In one place the wall was about 15 ft. high.

After the wall had been built, three lot owners decided to build homes and the question of how to make an approach arose. It was solved in two ways, both of which have been entirely satisfactory.

The owner who lived where the wall was lowest, cut through the wall, and ran the steps up parallel to it. This required that a second retaining wall be built on the opposite side of the steps. This is shown in Fig. 1.

The other two owners decided to co-operate and build a single stairway. They, however, chose to cut an arch through the wall and run a stairway direct from the street to the top at right angles to the sidewalk.



FIG. 1—TWO OWNERS CO-OPERATED IN MAKING THIS JOINT ENTRANCE THROUGH A RETAINING WALL

The other view shows how this was done.

At the top, the steps were built in semi-circular amphitheatre form so that direct entrance is had to either home. The appearance of this portion of the construction is shown in Fig. 2.

Both plans have worked well. There has been no dissatisfaction on the part of either, and the cost of construction was not greatly different when it is remembered that two persons built the one that required an archway through the wall.

Size of Cement Sacks

A cement sack is usually cut from 30-in. goods, in lengths of 34" to 36". When this is sewed up it makes a sack a little less than 30" long, usually about 29" and from 16½" to 17" wide, inside measurements.



FIG. 2—AN INCLINED ENTRANCE THROUGH A RETAINING WALL

¹⁰Andes—"Drying Oil and Boiled Oil," p. 33 April, 1914

A Discussion of Lime Putty and Cream of Lime¹

BY CLOYD M. CHAPMAN²

The specific purpose of the following tests was to determine certain constants of lime putty and cream of lime, such as the weight per unit volume, weight of lime in a unit volume, volume resulting from slaking and wetting a given weight of quick lime, etc. It was expected that fairly constant values would be determined for each of these various quantities so that by averaging several results a figure might be arrived at which would serve for general use in specifying lime mixtures.

It may be well to insert here that whenever the word "lime" is used in this paper it means the commercial article which is defined by the Lime Committee of the Am. Soc. for Test. Mat. in its tentative specifications as "a product resulting from the calcination, at a temperature below the cinder point of a material containing carbonates of calcium, or calcium and magnesium, which may be or has been converted to a paste or a dry flocculent powder by slaking."

In carrying out these tests the following procedure was adhered to:

Some eight dealers in lime in N. Y. C. were requested to forward to the laboratory 5-lb. samples of their lump lime. These samples as received were placed in air-tight metal cans to prevent absorption of moisture and air slaking.

A representative lump was chosen from each sample and its specific gravity determined by the displacement method, using water-free kerosene oil as the liquid. The dry lump of lime was weighed, then immersed in oil for 24 hrs. to become saturated, excess oil was then wiped from the surface and the lump again weighed. It was then suspended in the oil and weighed again. The difference in weight in grams of the saturated lump in air and oil divided by the specific gravity of the oil gave the volume in cc. of the lump. The weight in grams dry, divided by the volume in cc. gives the specific gravity. These data were sought merely as a matter of interest, to compare one lime with another.

Another sample of each lime tested was broken to the size of beans, slaked with water in a wide-mouthed bottle to which a reflux condenser was attached so that water evaporated by the heat of slaking would be returned to the bottle. This bottle had a ring mark around its neck at a point representing 300 cc.

After cooling, additional water was added to make a paste or putty of a certain consistency which was adopted as a

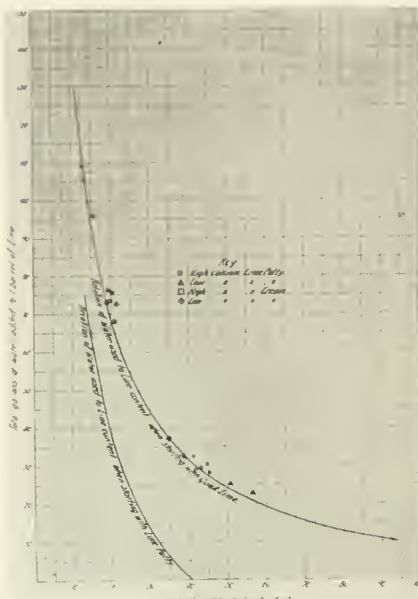


FIG. 1—CURVES SHOWING WATER REQUIRED FOR LIME PUTTY

standard for these tests. This consistency was such that with the Chapman consistency apparatus³ a drop of 3" would produce a spread of the lining of about 0.25" using a cylinder 1 7/8" in diameter and 3" high. This consistency is one suitable for use in regular work on the job. The flask was then carefully filled with water from a burette up to the 300-cc. mark in order to determine the volume of the putty. This water was run down the side of the flask so as not to mix with the putty. When the flask had been filled the water was carefully decanted, leaving the lime putty in the flask.

CONSISTENCY OF CREAM OF LIME

This putty was then thinned to the consistency of cream which was also standardized for the test by a method proposed by the writer. This consistency may be very definitely determined as follows: The paste is thinned gradually by the addition of small amounts of water at a time, taking care to stir the paste sufficiently after each addition of water to bring the mixture to a uniform consistency and break up all lumps. The addition of water is continued until the resulting mixture is of the proper standard consistency which is determined by dipping a wood paddle 2 1/2" wide by about 3/8" thick (the thin end of a shingle

makes a good paddle) into the cream and spooning up what cream can be lifted on the flat side of the paddle, which has been withdrawn from the cream in an inclined position as a spoon would be lifted. The paddle is now tipped up into a vertical position and if the cream on the paddle flows sluggishly off the end without the assistance of any jarring then the consistency is that sought. If the cream adheres and does not flow then it is too thick; if it flows freely it is too thin.

By this method one particular consistency may be determined with considerable accuracy, but, of course, the method is not applicable to any other consistency.

After the lime has been thinned to cream of lime the flask is filled to the 300-cc. mark on its neck with water from a burette to determine the volume of cream produced.

During the test the following quantities are taken and recorded. The metric system of weights and measures was used:

- a—Capacity of flask (300 cc.)
- b—Weight of empty flask.
- c—Weight of sample of lime.
- d—cc. of water added to lime to make putty.
- e—cc. of water added to lime putty to fill flask to 300 cc. mark.
- f—Weight of flask, lime putty and remaining water after decanting.
- g—cc. of water added to putty to make cream of lime.
- h—cc. of water added to cream to fill flask to 300 cc. mark.

From these data the following results were computed:

- 1:—Gals. of water required to make putty of 1 bbl. or 200 lbs. or 90,720 gms. of lime (1 gal. being equal to 3,786 cc.)

$$\text{Gals. water} = \frac{90,720}{3,786} \times \frac{d}{c}$$

- 2:—Lbs. of lime in 1 cu. ft. of the putty (1 cu. ft. being equal to 28,320 cc. and one lb. to 453.6 grams).

$$\text{Lbs. lime} = \frac{28,320}{453.6} \times \frac{c}{a-c}$$

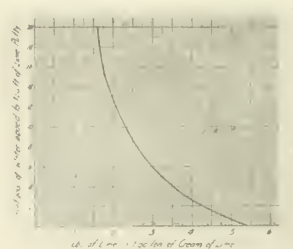


FIG. 2—CURVES SHOWING RELATION BETWEEN WATER ADDED TO PUTTY AND LIME IN THE CREAM OF LIME

¹From a paper presented before the 10th Annual Convention of the American Concrete Institute, Chicago.

²Engr. of Tests, Westinghouse, Church, Kerr & Co., N. Y. C.

³Described in CONCRETE-CEMENT AGE, p. 8, July, 1913

[illegible]

[183]

formula the lbs. of lime in 1 cu. ft. of any mixture of lime and water may readily be determined. The difficulty lies in knowing, or being able to determine, the amount of water that is actually added to the lump lime. This difficulty is brought about by the evaporation of a considerable portion of the water that is added to a lump of lime during the slaking process. Even if the water added to a barrel of lump lime is carefully measured there is no easy method of determining on the job how much water is left after slaking is complete. A series of trials made in the laboratory with all materials at room temperature of about 70° F. showed an average evaporation of about 20% of the water. This would probably vary a great deal depending upon conditions of temperature and amount of water used.

This curve is therefore of small practical value to the man on the job. Another curve is also plotted in Fig. 1 which shows the relation between lbs. of lime in 1 cu. ft. of mixture when the amount of water which is added to putty to reduce it to cream is known. This curve is based on the assumption that the average amount of water has been used to make the putty, which, from the average in Table I, is about 31 gals per bbl. of lime.

On this assumption the formula for the curve becomes:

$$y = \frac{200}{x} + 4.92$$

7.5

In this all factors are the same as in the formula for the first curve except the constant 4.92, which represents the volume in cu. ft. of putty produced by 1 bbl. of lime.

By means of this curve, if it is known how many gallons of water are added to the putty produced by 1 bbl. of lime to reduce it to cream it can be determined how many lbs. of lime are contained in each cu. ft. of the cream, whatever its consistency.

Inasmuch as the amount of lime in 1 cu. ft. of putty is a reasonably constant quantity, and as it is usual for lime to reach the stage of putty at some time in the process of preparation, it seems that this offers the best basis on which to build up a specification for mixing mortars.

If a high calcium lime is to be measured when in the putty state, having a consistency of rather soft butter it may with reasonable accuracy be assumed to contain 41.5 lbs. of CaO per cu. ft.

But if the lime is to be measured in the liquid state, having a consis-

tency of good, rich cream, in which condition it is most easily mixed with sand and cement to a uniform mortar, then some means must be provided to determine the amount of lime in a given volume. The variation between different limes in the amount of water they require to make a cream of a given consistency is so great that no general figures can be safely applied.

To put these data in the most usable and convenient form a third curve is given in Fig. 2, which shows the relation between the gallons of water added to 1 cu. ft. of putty of standard consistency to reduce it to cream and the number of lbs. of lime in 1 gal. of the resulting cream regardless of its consistency.

The simplest way to measure lime putty is by the cu. ft. just as stone is measured: by using the bottomless box. The easiest way to measure water is by the gallon, either in a barrel or a 12-qt. bucket. The easiest way to measure cream of lime is by the gallon in a 12-qt. bucket. Using these most convenient units as a basis, from the curve given in Fig. 2 there can be determined quickly the number of pounds of lime in a gallon of cream if it is known how many gallons of water were used to thin each cu. ft. of putty to produce the cream.

Suppose, for instance, that the plasterer prepared enough lime putty in advance to do a job of stucco. When ready to use it he reduced 5 cu. ft. of the putty to a cream by adding 50 gals. or 1 bbl. of water, or 10 gals. per cu. ft. The resulting cream, from the curve, would have 2.3 lbs. of lime per gallon. This is found by following the horizontal line from the point in the left hand vertical scale representing 10 gals. per cu. ft. over to the curve and from that point following the vertical line down to the lower horizontal scale which gives the result, namely 2.3 lbs. per gal.

Suppose that with this cream the plasterer wished to add 10% of lime to a two-bag batch of cement-sand mortar. This would mean that he would want enough of the cream of lime to give 19 lbs. of CaO. As this cream contains 2.3 lbs. per gal. he would have to add 8 1-3 gals. or 2¾ buckets of 12 qts. or 3 gals. each.

It may be well to add here a caution against accepting the figures given above for general use until they have been either verified or modified by tests made on a much greater number of samples obtained from many parts of the country.

Yardage of Concrete Roads in the United States

The increase in concrete road construction is shown in two columns of figures compiled after careful research by the Assn. of Am. Portland Cement Mfrs. The figures show the yardage of concrete roads in the U. S. prior to 1913 and the yardage added in 1913—almost as much as that previously laid.

CONCRETE ROADS IN THE U. S.
(Square Yardage)

	Prior to 1913	1913 Work
Alabama	41,300	36,800
Arizona .....	.....	6,800
Arkansas	93,000	123,800
California .....	.....	.....
Colorado	10,700	77,800
Connecticut	71,000	115,200
Delaware	50,200	21,000
District of Columbia	3,000	6,300
Florida	30,000	50,000
Georgia	1,000	28,300
Idaho	110,000	119,000
Illinois	267,840	280,780
Indiana	150,440	.....
Iowa	1,031,870	632,710
Kansas	200,300	50,615
Kentucky .....	.....	91,000
Louisiana	168,700	91,000
Maine	70,900	512,300
Maryland	131,100	68,650
Massachusetts	224,975	533,050
Michigan	1,016,055	200,770
Minnesota	193,300	38,500
Missouri	16,400	614,190
Montana	699,400	.....
Nebraska	80,200	35,000
New Jersey	33,500	90,400
New York	1,581,700	891,855
North Carolina	30,400	124,800
North Dakota	60,000	19,200
Ohio	507,250	865,650
Oklahoma	13,400	.....
Oregon	972,700	35,000
Pennsylvania	70,130	127,210
South Dakota	30,800	15,600
Tennessee	105,360	21,000
Texas	36,950	81,610
Utah	2,000	.....
Virginia	29,120	7,300
Washington	196,650	471,100
West Virginia	7,700	33,550
Wisconsin	535,410	503,000
Wyoming .....	.....	21,850
Total	8,903,860	7,116,100
Grand Total	16,022,260	

Short Cuts in Steel Weights

To find the weight of square or flat iron or steel bars, multiply the sectional area of the bar by 10/3, which will give the weight in lbs. per lin. ft. Add 2% for steel. For example, in the case of an iron bar 1½" x 1½":

$$3/2 \times 1/2 \times 10/3 = 5/2 \text{ or } 2\frac{1}{2} \text{ lbs. per lin. ft.}$$

For steel, add 5/100=2.5 lbs. per lin. ft.

In the case of round steel bars, to find the weight per lin. ft., divide the square of the number of quarters of an inch in diameter by 6. For example, in the case of a steel bar ¾" in diameter:

$$3 \text{ squared (three being 3 quarters)} = 9, \text{ divided by } 6 = 1\frac{1}{2} \text{ lbs. per lin. ft.}$$

These short methods are useful when a handbook is not readily available.—*Iron Age*.

Building Low Cost Concrete Houses in England

The accompanying illustrations show something so frank and original in the use of concrete units in the construction of modest dwellings and farm buildings, that we present them here through the courtesy of *Concrete and Constructional Engineering*, London, Eng.

The buildings were erected in England. Their chief claims to interest are their low cost, their double wall construction and their absence of any imitation of the construction types which belong to other materials. They are not in the style of frame buildings nor brick buildings. There seems nothing unnecessary about them, architecturally. The large block unit has here proven a distinct advantage.

They are included in extensive operations at Norfolk, England, on the Wayford Wood Estate at Stalham.

The walls of the buildings are 10" thick, built of $4\frac{1}{2}$ -in. blocks with a 1-in. air space between them. The block are 18" x 9" x $4\frac{1}{2}$ ".

Fig. 1 shows a cottage with three rooms on the ground floor with a scullery and larder, and three rooms on the top floor.

The living-room is 16' x 10' 8", while the scullery is 8' x 10' 8", the larder 6' x 4' 3". The dimensions of the remaining two rooms on the ground floor are 14' 6" x 9' and 11' x 8'. The three bedrooms on the top floor are each 12' x 10'. The total cost of this cottage, including painting and distempereing, was £200 (about \$975).

Fig. 2 shows a somewhat larger cottage, with a living-room, 16' x 11'; two sitting-rooms, respectively 10' x 14' 6" and 13' x 16'; a larder, 6' x 4' 6"; a scullery, 8' 6" x 11', all on the ground floor. The top floor has four bedrooms, respectively 13' x 16', 13' x 12', 14' 6" x 10', and 12' x 8'. The total cost of this building was £210 (about \$1,025).

Fig. 3 shows a block of farm buildings recently completed. They comprise a harness-room, stable for two horses, a cow byre for four cows, and four pigsties. In this instance the walls are $4\frac{1}{2}$ " thick. The roofs of all the buildings on the estate are of concrete tiles.

The cost of laying block (the size of which is as indicated above, and therefore each block equals six brick) is £3 6s. (about \$15.33) per 1,000, while the cost of laying brick is 15s. (about \$3.65) per 1,000 at



FIG. 1—CONCRETE BLOCK COTTAGE AT WAYFORD WOOD ESTATE, NORFOLK, ENGLAND, COSTING ABOUT \$975



FIG. 2—BLOCK COTTAGE COSTING ABOUT \$1,025



FIG. 3—FARM BUILDINGS OF CONCRETE BLOCK

least. Therefore, to cover an area of 1,000 block, 6,000 brick are needed, the laying of which would cost £4 10s. (about \$21.60).

A Suggested Self-Aligning Wall Form

Wall form problems are always of interest. To many of us they are really vital, and the accompanying sketch shows a suggested form worked out by a member of the staff of CONCRETE-CEMENT AGE, which, in the opinion of several practical builders, should be of real value. The idea, at least, is offered for what it is worth. The suggested improvement in wall centering confides itself entirely to the stud and leaves the sheathing used entirely optional.

In wall work, automatic alignment is of the greatest value. It is of such importance that on a great deal of work it is really worth while to use studs the entire wall height so that an absolute true wall, vertically, is assured.

The sketch shows an extension stud built of two duplicate pieces of channel iron, preferably. Each piece of channel iron, which can be of any convenient length from 3' to 4' up, has three holes bored, one at each end, and one in the middle. As shown by the center sketch, the two pieces of channel iron are assembled back to back, and held rigidly by two clip bolts and wedges, to make a stud $1\frac{1}{2}$ times the length of either individual piece.

In this shape, the stud is used as an ordinary wooden stud, being wired or bolted into place as required and centered with sheathing to its full height.

When the time comes to raise the centering, the clip bolts at the center of the lower section and at the bottom of the upper section are taken out and the lower section of the stud *B* is revolved around the bolt *C* to take the position of *B'*, as shown in the sketch at the left. The clip bolt *D* is replaced through the hole *D'* in the upper part of *A* and in the center of *B* and we have a stud of the same length as before, moved half its length upward and in exact alignment ready for more sheathing.

As a matter of fact, there is no reason why this extension stud could not be treated as cantilever centering and be held rigidly in place by bolts or wires in the lower section so that no braces would be required.

The idea is probably applicable to short pieces of 2-in. x 4-in. which could be used on any small house construction. Any mill could turn out very easily as many pieces of 2 x 4's with rounded ends as required.

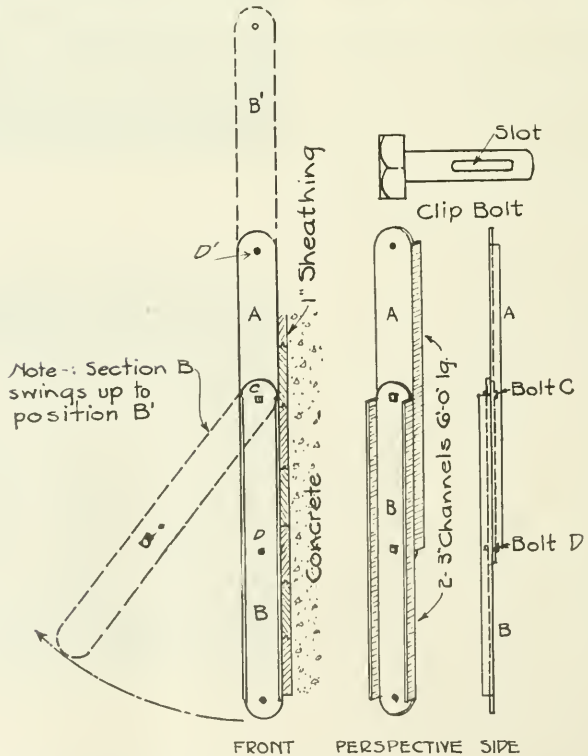
hesitates to offer any suggestion until it has been actually tried out and proven good. This idea, however, has been passed on by several practical men and there is no doubt that it would work out in some way, and the suggestion should prove of value to CONCRETE-CEMENT AGE readers with wall centering problems to meet. We shall be glad to keep in touch with our readers covering actual application of this suggestion, which we now state is not patented and, as far as we are concerned, will not be patented. It is a free-for-all idea, at least.

Plain But Attractive Porch Columns Cast in Place

A feature of this concrete block house is the porch columns, trim and shapely. When H. D. Scott, Eden Park, R. I., had laid up the block which form the bases for the columns, he set up molds of his own making and cast the columns in place. The mold cost only about \$2.00 for material and labor an answer for all the columns. Each column used about one bag of cement.



PORCH COLUMNS CAST IN PLACE



SKETCH SHOWING TWO-PIECE SELF-ALIGNING EXTENSION STUD

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Neat Cement on Sidewalk Surface

DISCUSSED BY J. F. GRAY¹

"In sidewalk work, what is the advantage of floating cement on the top before the final finish? Doesn't this practice introduce many factors making for checking and a too slippery surface?"

BY MR. GRAY

Referring to the discussion on p. 34 of the Jan., 1914, issue, Mr. Carey states that if the cement is well floated in, there is no possibility of checking unless the walk is exposed to a hot sun, provided, of course, that the cement is not too fresh or hot with lime.

Now, if Mr. Carey will enlighten us on the best means of detecting this "too fresh or hot with lime" cement, he will confer a favor on the average cement worker, which will doubtless be greatly appreciated.

Every sidewalk finisher knows that no more floating or troweling should be done than is absolutely necessary to give the walk a good smooth surface. The reason for this is that the more the walk is floated and troweled, the more the grains of sand are forced below the surface and the neat cement (cream) is brought to the top.

To float neat cement into a walk surface, which is already rich in cement is, in my opinion, a waste of time and cement, and much labor, and while a surface thus treated would be susceptible of a fine, smooth finish, yet you must be on the lookout for map-cracks or hair-cracks, for they are sure to appear sooner or later.

Mr. Carey also states that this method improves the wearing surface at least 50%. To this I do not agree, for the reason that any concrete walk that has been subjected to much traffic will show that this glass-like surface, which is composed entirely of neat cement, has worn away and has left exposed a surface of particles of sand or aggregate, on which there will be no perceptible wear for a great many years.

It is my opinion that an excess of neat cement on a walk's surface is in no way desirable and that a top coat that is just rich enough in cement to admit of a good finish with an ordinary amount of floating and troweling will give the best results in the long run.

Storage Tanks for Oil

DISCUSSION BY J. F. BUTLER²

"Can concrete be used to build tanks for storing oils, both vegetable and mineral?"

BY MR. BUTLER

Referring to the discussion, p. 79, Feb., 1914, issue, which described some laboratory experiments on the action of oil upon concrete surfaces, treated with glue and potassium bichromate, it is our opinion that in general there is not much difficulty in finding a composition to use as a coating for a small experimental mold, to prevent the oil from percolating to the concrete. We do not think, however, that in practice the use of such coating could be relied upon.

If reinforced concrete tanks are to be used for oil storage some ma-

terial must be found to mix throughout the whole of the concrete to protect the concrete from the effects of the oil. If a coating only is used there may be invisible cracks or holes which will allow the oil to get through to the mass of concrete and do the damage before the fault happens to be discovered; this, we think, is the risk.

Cause of Caked Cement

DISCUSSED BY C. W. BOYNTON³

"What is the cause of cement caking in sacks and getting hard when left in storage longer than two months? The storage is dry and airy. How can the condition be remedied?"

BY MR. BOYNTON

Cement, like lime, has a great affinity for moisture, and when cement is stored for a number of months, such as over winter, it is possible that the cement in the outer sacks in the piles may become more or less caked or lumpy by absorbing moisture from the air circulating through the building. If the lumps can be crushed in the hand the cement is still useful for any work, though probably somewhat slower acting. If the lumps are hard, however, the cement is not suitable for important work, though it may be used in mass foundations, etc. The lumps should be screened out and discarded.

When cement is stored in high piles for long periods of time, the cement in the bottom sacks sometimes becomes compacted and takes on what is known as "storage caking," which is mistaken for caking due to moisture. This, however, does not

¹Portland, Ind.

²Sec., British Reinforced Concrete Engrg. Co., Westminster, London, Eng.

³Engr. in Charge, Information Bur., Univ. Portland Cement Co., Chicago

injure the strength of the cement in any way, as the sacks can easily be shaken up when they are rehandled.

The condition of the cement in the building in question may result from insufficient ventilation. For the proper storage of cement it is essential that in addition to providing a weather-tight building care should be taken to see that there is proper ventilation.

The cement sacks should be piled

at least 8" away from the ground and from any wall, so that a free circulation of air may be obtained. Where the floor of the building is laid directly on the ground, it is then well to raise the cement an additional 8" by means of a false floor so as to insure proper ventilation underneath. With a weather-tight warehouse and proper ventilation, cement can be kept in good condition for months.

cluding the reinforcing rods, wire mesh, etc. I first pour the mixture of concrete 1:6, leaving enough depth to put on a coat 1" thick of 1:3 or 1:4 rich top mixture. I have, all ready before starting, a frame-work made of 1-in. x 2-in. strips of whatever length is necessary and set apart about 31" to receive the roofing of 32" in width. Cross-pieces are nailed across the frame about every 4', cutting out "half and half" to make a smooth surface. Holes are drilled in the strips to receive bolts which hold these strips down into the concrete, placed as accurately as possible.

While placing the first pouring of concrete, expansion shells are set in line to conform with the spacings of holes in the framework. It is necessary to take precautions not to let the shells slip out of place or be covered up with the concrete. Let the concrete set sufficiently to hold the shells firmly. Then the framework is set down carefully so that bolts through the holes in the frame are right over the shells. Do not, however, put in the screws or bolts yet, but set nails loose in the expansion shells and the holes in the strips so that the framework will not move. Then fill in with a rich concrete to the level of the tops of the strips. Trowel this to a smooth finish and use an edger along strips, making about a 1/4-in. joint to allow for the expansion of the concrete.

When this concrete has set firmly and is ready for the roofing, remove the nails and set screws or bolts to hold the strips down. This produces a satisfactory slab base to nail on without any chance of getting out of line. When I am ready to lay the roofing on I first use a regular liquid cement over the wooden strips. When the roofing is down I apply three coats of liquid cement over the nails and where the strips come. I also nail and cement cross-pieces, which makes a tight job. I have yet to see my first leak and I have not had one complaint.

The reason underlying the use of bolts and the expansion shells to hold wooden strips is that it gives a firm, solid base to nail on, and in case of repairs there is no danger of ripping out other good portions which are not anchored firmly. The hot, dry climate of this section causes more or less shrinkage in composition roofing in time. Some kind of fastening must be used, and in place of driving nails on underside and sides of strips and setting them in the concrete while wet, I use bolts and ex-

Methods of Applying Composition Roofing

DISCUSSED BY: L. C. WASON¹; C. M. LEONARD²; A. B. TRYON³

"What is the best method of applying prepared roll roofing to an incline concrete roof? Is it necessary to embed nailing strips or can I depend on an adhesive cement?"

BY MR. WASON

In regard to the use of composition or built-up roofing when applied to concrete roof surfaces, I would say that it is our usual practice to clean the roof thoroughly, mop it with hot pitch and roll the paper on while the pitch is hot—thus sticking it down. Inasmuch as every layer is mopped, we use 3-ply roofing instead of the usual 5-ply which is used on boards, two layers of which are laid dry and held down with nails.

In a few exceptional cases we have embedded wall plugs or other similar devices, into which nails are driven.

In regard to the use of prepared or ready roofing, I would say that we have never used this on a permanent concrete roof, but from our experience with it on permanent and on temporary wooden roofs, we should say that it would not be necessary to use a nailing strip, but in its place it would be necessary to mop the roof and roll the ready roofing into it in order to stick it down. I have seen this applied on one occasion by another contractor, using this method. This roof was laid some six or seven years ago. I have not seen or heard of it since, but think it is still in place.

BY MR. LEONARD

In regard to the best methods of placing composition roofing on con-

crete roof slabs, we believe that on account of the condensation in this latitude it is necessary to install a poor cinder concrete on top of all concrete roof slabs. This permits the construction of cheap saddles necessary to drain the water to down spouts. In this cinder concrete there should be embedded nailing strips to which the roofing should be fastened.

On account of wind, expansion and contraction, these nailing strips are necessary. This has been proven absolutely in our experience and in that of others whom we have consulted. It is bad practice to attempt to fasten a prepared roofing by any kind of adhesive cement directly to the concrete slab, or to the cinder concrete filling.

BY MR. TRYON

In discussing the problem of applying composition roofing to concrete surfaces I should like to mention first the fact that I do not know of course in what section of the country the above question arises, and as all my work has been out on the desert and confined to sections of the country where the temperature ranges between 40° and 125° or 130°, with a very light rain-fall, I cannot answer the question in a way that would suit all concerned.

From my observations of work being done by the experimental builders of this section for fireproof buildings, I note they all stick pretty well to a general idea of laying wooden strips lengthwise of the roof for slight incline or flat, embedded in the surface of the concrete. The composition roofing is nailed to strips.

In my work I have all the form work ready for pouring concrete, in-

¹Pres., Aberthaw Const. Co., Boston

²Leonard Const. Co., Chicago

³Needles, Cal.

pansion shells, which gives me the sides of strips on which to use an edger to push away the top coat of concrete $\frac{1}{4}$ " from the strips to allow for expansion and contraction of concrete.

Waterproofing Against Pressure

DISCUSSED BY:
RALPH L. SHAINWALD, JR.

"How is it best to waterproof from the inside against a small leakage of surface water? There is a receiving well here for the water works and the surface water is coming through. I have never waterproofed against pressure from the outside."

By MR. SHAINWALD

Probably the best method of repairing this at the minimum cost is to apply a $\frac{3}{4}$ -in. facing of mortar containing a waterproofing compound which will be unaffected by time or the elements. This facing may be applied to the inside of the wall, even though the water pressure is from the outside.

The first step would be to chip and roughen the surface so as to secure a good mechanical bond with the old concrete. Then wash the surface with a 1:4 mixture of muriatic acid and water, respectively. This acid wash should be well flushed off with fresh water and then there should be applied a wash of neat cement and water thinned down so it can be applied with a whitewash brush. Following this, trowel on the first coat of waterproofed mortar about $\frac{1}{4}$ " thick. Make up a small amount only of the cement grout at a time and apply to the wall so that it can be followed with the mortar coat inside of 20 min.

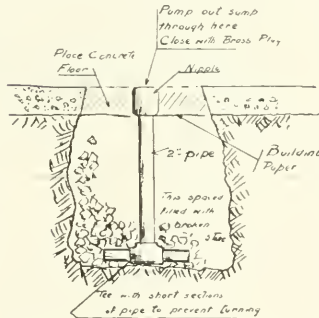
A 1:2 mortar should be used to which waterproofing has been added in the proper proportion.

After the first coat has been floated, it should be well scratched to receive the second coat. This second coat is the same mixture as the first, and may be applied as soon as the first is hard enough to carry it. This should also be well floated to close up all cavities. It should then be scratched and a third coat applied as before.

The preceding directions would cover ordinary cases of waterproof-

ing, where the percolation through the walls is not severe. If, however, a considerable amount of water is flowing through the walls, a different procedure must be adopted. For this reason, it is sometimes advisable to postpone the work until the dry season of the year, but this is not necessary if means are taken to relieve the water pressure temporarily. One of the simplest means for relieving the pressure is to dig a sump or pit, to a level 2' or 3' lower than the floor, keeping this pit pumped out, thus draining away the water from the whole area in which the structure is located and preventing percolation through the walls or floor. If convenient, this sump may be driven outside of the structure, but can also be driven inside and then closed up when the work is finished, as described later. On large work, two or even three sumps are sometimes advisable.

The general structure of the geologic formation should determine largely what method to choose in relieving the pressure long enough for the waterproof mortar to harden. Another simple method for relieving the pressure is to drill a hole partly or completely through the wall and then insert a small iron pipe, which



SKETCH SHOWING ARRANGEMENT OF PIPE AND FILL FOR "HEALING" A SUMP-PIT

will make a free passage for the water and carry it clear of the face of the wall. This pipe should be embedded in mortar and will provide such an easy path that the water will flow through the pipe in preference to pushing through the wall. After the pipe or "bleeder" has been in place for a short time, no water will come through the face of the wall within several feet of the bleeder. It is then possible to apply the waterproof mortar right up to the bleeder. After the waterproofed mortar has set for a few days, the bleeder may be removed by twisting

and the hole stopped by means of a wooden plug driven in 2" from the face of the wall, the remaining 2" being plugged with waterproofed mortar containing an additional amount of dry cement to make it specially stiff.

There are other methods for handling a problem like this and, in general, plans will have to be adapted to special conditions. The main point to be considered is that no cement mortar will set up properly while water is flowing through it. This flow of water must be stopped, at least for a few hours, until the mortar has set up. After the waterproofed mortar has hardened, no more trouble need be expected. It should be pointed out, however, that when working against high pressures, the new coating should not be strained before it has set sufficiently to gain the necessary strength. When working against a 10-ft. head of water, for instance, the mortar facing should be allowed to harden for 4 das. or 5 das. at a moderately warm temperature before allowing the water pressure to come onto it.

Where the leakage through the wall is very small, it is advisable to apply the first coat just as if there were no leakage. After the whole wall has received the first coat, it will be found that the mortar may have washed off in one or two places where the leaks were worst. These, then, are the places where bleeders may have to be used. The use of quick-setting cement in these places should be handled with great caution, as most quick-setting cements deteriorate with age.

Regarding the sump-pit referred to above, this may be closed as follows: Take a 2-in pipe and screw a coupling to one end and a "T" to the other. Set this in place so that the "T" rests at, or near, the bottom of the sump, the coupling being flush with the level of the finished floor. It is a good plan to screw a couple of short pieces in the "T" to prevent it from turning. Surround the pipe with broken stone; on top of this lay some building paper and then deposit concrete and top facing, as on the rest of the floor. While this is hardening, the sump may be kept pumped out by means of a smaller pipe inserted in the 2-in. pipe. After about 4 das., or when the concrete is thoroughly hard, pumping may be stopped and a 2-in. brass plug screwed in. This will seal the sump flush with the floor and can easily be removed in case it is desired to use the sump for any reason at a later date.

¹Standard Paint Co., N. Y. C.

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Living in Concrete Houses

A LETTER FROM L. N. BABBITT¹

I am glad to make a statement as to the living conditions as we have found them in our concrete houses during the last three years. These houses, it will be remembered, were built by Mr. Hazen, Mr. Fuller and myself, in 1910, and were described in the May, 1911, issue of *Cement Age*. Briefly, the houses are of solid reinforced concrete with reinforced concrete floors and stairs. The roofs are of tile on wooden rafters and decking. The outside walls are 8" and 6" thick and are furred on the inside. A 1-in. air space is left between the wall and the plaster on metal lath. The bearing walls and the ceilings were finished by rubbing smooth with carborundum brick and left in this condition. The partition walls are plaster on metal lath. The floor surfaces in the three houses are oak for the second-floor sleeping rooms, tile and concrete for the living rooms. The cost of these houses was \$7.50 per sq. ft. of gross area. This included $\frac{1}{2}$ of the porch area.

After our experience of four winters, I can say that we much prefer this type of construction to the frame dwelling. The past winter has been unusually severe, with zero temperatures accompanied by very high winds. In spite of our exposed position the wind and weather have in no way affected the interior comfort of our houses. One thing stands out forcibly, and that is the solidity and tightness of the concrete house in a high wind.

In my own house, of about 1,200



A MONOLITHIC CONCRETE HOUSE AT DOBBS FERRY, N. Y.

This house, one of a group of three, has solid reinforced concrete walls, floors and stairs. Note that this view is practically identical with the view shown on p. 231 of May, 1911, *Cement Age*

sq. ft., I have burned about 12 tons of coal each winter, and every one of our 10 rooms has been comfortable. From our own experience the heating proposition presents an interesting point. The temperature of our main floor rooms has seldom been above 70° F. and with very few exceptions has not been below 60° F. In other words, during the entire winter the hot water system has been so operated as to keep the rooms within a range of 10°. This, of course, does not apply to the sleeping rooms. This regular temperature is possible because the concrete partition walls and floors seem to absorb any excess heat, and if the fire gets low at night the radiation from the concrete keeps up the room temperature. Another point is that with solid floors there are no drafts and the difference in room temperature between the floor and the ceiling is very

little. I have no figures on this, but it is nothing like the rooms in some frame houses where the difference is sometimes more than 10°. Perhaps the reason for this even temperature is the heat in the concrete floors, and perhaps also very slight convection currents produced by the outside walls, which, while furred, must have some effect upon the room temperature.

In summer time the houses are very comfortable and I think have an advantage over the frame house in evenness of room temperature. That is, the interior does not fluctuate with the mid-day heat.

We have not experienced dampness at any time.

Our concrete floors we have found comfortable and easy to take care of. After our experience with oak, concrete and tile, our choice would be the latter. A good quality of tile,

¹Sec. Hazen & Whipple, Consult. Civil Engrs N. Y. C.

well laid, is decorative, comfortable and can be kept immaculate. Where children are in evidence, and several times a day bring in snow, mud and water to the main hall, the tile is much to be preferred, as all that is needed is a mop to restore it to its original condition.

The exteriors of the houses seem to improve with the weathering, and both exteriors and interiors have proven satisfactory. There has not been the slightest settlement in any of the three houses.

In regard to the matter of training vines on concrete surfaces, there is one vine only that I know of which will stick, and that is the Ampelopsis

Veehii, or Japanese ivy. This does pretty well but sometimes the high winds tear off the small ends. The vine is prolific and I think will stick permanently to a concrete wall. The English ivy is much prettier to my mind, and I have planted some of this. It has not gotten well started and when it does I expect I shall put up a trellis for it to grow on.

Not a dollar has been spent for repairs and no insurance is carried. To our way of thinking the concrete house is a much superior type of construction, with many advantages and none of the disadvantages which are encountered with even well built frame dwellings.

one-half mile from the center of the section of subway under contract, and two motor trucks.² 7½-ton capacity, are used to transport the mixed concrete from the plant to the place of deposit. The boxes on the trucks have a capacity of 4 cu. yds.; that is, two complete batches of the mixer. The trucks are power-dumping and were built with an automatic release back door. This door has been replaced with a steel door designed and built by the contractors, the top part of which is fixed to the body, and the bottom third only opens. This movable part of the door is held closed by heavy steel hooks which have take-up screw adjustment. The trucks are also fitted on the sides with inclined running boards. These are level when the truck is dumping.

When a section is ready for concrete, holes are cut in the wooden street decking at suitable intervals and a line of 8-in. conical sheet metal spouts in 5-ft. sections is hung to

Handling Concrete with Motor Trucks on N. Y. Subway Work

A LETTER FROM A. B. LUEDER¹

On Section 13 of the Broadway-Lexington Ave. subway, the contractors, McMullen-Snare & Triest, Inc., have some 70,000 cu. yds. of concrete (mostly 1:2:4 mixture) to place on this section in the roofs, walls and inverts, from street level to 60' below the street. The concrete plant was designed with the idea of a maximum output at the minimum cost for handling the raw materials, mixing the concrete and placing it.

The plant is situated at the dock at the foot of E. 125 St., N. Y. C., and consists of two stiff leg derricks with 85-ft. booms, an orange peel bucket, elevated gravel and sand bins of approximately 600 cu. yds. capacity, and a cement shed of 10,000 bags capacity.

The raw materials are delivered on scows at the dock alongside, and are loaded by a force of men at night, as the derricks are used for handling rock muck during the day shift. An 80-cu. ft. capacity steel measuring car runs on a track under the gates of the sand and gravel bins, and over the mixer hopper, where it dumps. The cement is then added through a chute from the cement shed above, and the materials are dumped into the mixer. The car is pulled back and forth by an endless rope on a single drum derrick-swinging engine.

The mixer is a 2-cu. yd.² mounted on a concrete base to deliver concrete

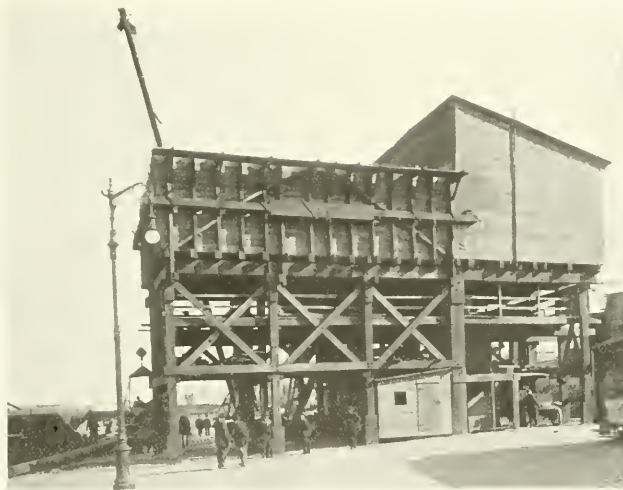


FIG. 1—A PLANT TO PRODUCE CONCRETE FOR N. Y. C. SUBWAY WORK

This plant is located at the foot of E. 125th St., N. Y. C. At the extreme edge is shown the dock side with the barges which bring concrete material by night and take away excavated material by day. The aggregate is unloaded and placed in the bins with an 85-ft. boom. A dump car runs under the bins, dumping into the mixer shown at the right. A motor truck is shown receiving a load of concrete

about 10' from the ground. The mixer is driven by a vertical engine which takes steam from a central boiler, supplying also the derrick engines.

In winter live steam is fed into the sand and gravel bins, and into the mixing water, to prevent freezing, and the bins are covered with canvas to keep out rain and snow. The concrete plant is situated approximately

lead from the holes in the decking to the forms. The sections are slung one below the other by chains. Over the hole in the decking is placed a wooden hopper 7' x 13' and 20" deep, with bottom battering to the hole, and fitted with a steel sliding gate. The truck backs up to the hop-

¹Supt., McMullen-Snare & Triest, Inc., N. Y. C.

²Ransome Concrete Machy. Co., Dunellen, N. J.

³Mack trucks, International Motor Co., N. Y. C.



FIG. 2—A MOTOR TRUCK DUMPING CONCRETE INTO A RECEIVING HOPPER

This shows the running board on which the men can stand

per, dumps its load into it and is away in about two min.

The concrete is mixed wet at the dock and at the hopper most of it slides out immediately the truck dumps. Usually a little water is added at the hopper. For cleaning the box and the edges of the door an air jet is used and is found to act perfectly. The concrete runs by gravity down the chute, which can be swung about below as desired, and the rate of feed is controlled by the gate in the hopper above. No shov-

els or picks are necessary in getting the material from the trucks into the forms.

The receiving hoppers are on skids and are not connected with the spout or the decking. They are pulled from one opening to another by

absolute data are at hand as to the cost of mixing, hauling and placing, but the trucks involve a total cost of \$25 per day per truck.

Fig. 1 shows the cement shed, sand and gravel bins, floor for the measuring car, and the derricks which are used to handle the raw materials. At the right the truck is shown in position to receive its load of concrete at the mixer.

A side view of the truck dumping is shown in Fig 2 (239), which shows also the running board placed alongside the truck by the contractors in order to facilitate the cleaning of the body, and illustrates how clean and free from construction material the streets are while the concrete is being placed.

In Fig. 3 is shown the 7½-ton "Mack" truck dumping. The illustration shows very distinctly the box into which the truck dumps, placed along the side of the street out of the way of the car tracks. It shows how well the material dumps from the truck and how the concrete re-



FIG. 3—A MOTOR TRUCK DUMPING INTO A HOPPER ON THE STREET; BELOW, A DETAIL VIEW OF THE RECEIVING HOPPER

This shows a man up on the running board, cleaning the dump box with an air jet. Below is shown in detail one of the receiving hoppers. These are moved from place to place by motor trucks

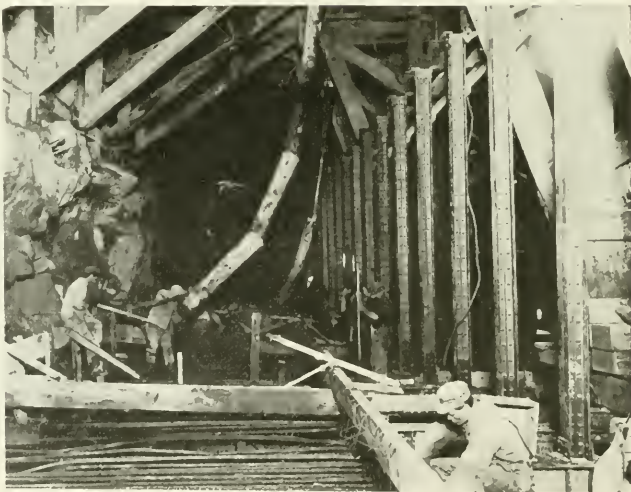


FIG. 4—RECEIVING THE CONCRETE DOWN BELOW IN THE SUBWAY

In the background can be seen the jointed sections of conical conduit which brings the concrete down from the street above.

hitching them with a chain to a truck. The trucks make a round trip from the mixer to the place of dumping and return to the mixer in from 15 min. to 20 min.

So far the contractors have regularly used two trucks with occasionally a third truck, the last of 3 cu. yds. capacity. Owing to the weather and other conditions, the plant has up to the present time never had a capacity trial, but has handled about 300 cu. yds. in 8 hrs. As yet no

maining in the truck is removed by means of an air jet and the truck washed out by water. The new type of door made by the contractors is also shown quite clearly.

The rock cut, concrete forms and the spouts, which extend from the hole in the street decking above to the forms below, are shown in Fig. 4.

This plant was designed and erected by the contractors themselves, W. J. R. Wilson, engr.; A. B. Lueder, supt., and W. Melvin, asst. supt.

Uses of Concrete in Connection with Two Louisville Houses



FIG. 1—REAR VIEW OF WALTER L. VAUGHN RESIDENCE, LOUISVILLE: ARTHUR SMITH, ARCHITECT

The accompanying illustrations (Figs. 1 and 2) show a house designed by Arthur Smith, archt., for Walter L. Vaughn, Louisville, Ky., and built on a beautiful site overlooking one of the city's natural parks. It contains several interesting examples of well-handled concrete. The exterior finish is stucco throughout, placed by the spatter-dash method. On this as on other houses designed by Mr. Smith, an attractive effect is produced by using a bundle of twigs, about 10" long, and ranging from $\frac{1}{8}$ " to $\frac{1}{4}$ " in diameter, in applying the finishing coat. Another feature of his practice in applying stucco is that after the second coat of the material has been put on, he has two coats of waterproofing applied, the final "spatter-dash" coat being put on top of this. He has found this preferable to the use of any waterproofing mixture with the stucco.

Mr. Smith's specification for stucco on a frame house requires on the second coat of stucco (which is allowed to dry for about three days) two coats of Insulite,¹ the waterproofing referred to. This is necessary for the reason that it would be difficult to apply Insulite, which is a liquid, on a soft surface. The spatter-dash coat is applied on top of the waterproofing, and this final coat of stucco must be liberally applied, in order to cover completely the black of the Insulite.

At the rear of the Vaughn house is

a two-column pergola built upon a 5-ft. recess, which occupies the middle of the rear wall of the house, with a door opening upon it from the well-lighted living room. The columns which support the beams of the pergola, one on each side of the recess, are about 8' in height, and taper from 16" in diameter at the bottom to 14" at the top. They are surmounted by square concrete caps, 24" x 24".

The columns themselves are monoliths, cast in place in wooden forms, and reinforced at the centers with a single 1-in. iron rod. The columns were started 2' 6" below grade, giving them ample support, and no foundations were considered necessary. The caps were cast separately, and the completed columns covered with stucco.

The concrete balustrade which edges a small second-floor balcony on the front of the house contains 17 balusters, 18" high and about 7" in diameter. These were also cast on the job, a metal form made to design in a local tin shop being used.

A mantel of simple and handsome design is the principal architectural feature of the big living-room, and this, too, is of concrete. It is about 6' 6" wide and 5' high, the shelf having a surface 16" wide, supported on brackets of simple design. The hood over the opening of the fireplace is of concrete, and this and the shelf were cast in place and finished smooth. The breast of the chimney and the rest of the mantel are stuccoed on brick. An individual touch is given by a Harvard seal of large size, in metal and enamel, mounted on oak, which is set in the center of the mantel below the shelf.

A larger and considerably more elaborate mantel designed by Mr. Smith is that in the Harrison Robertson residence in Louisville (Fig. 3). It consists of an 8-ft. shelf at



FIG. 2—SUN ROOM WITH CONCRETE FIREPLACE, VAUGHN RESIDENCE

¹Insulite Chemical Co., Aurora, Ill.



FIG. 3—SUN ROOM AND CONCRETE FIREPLACE, HARRISON ROBERTSON RESIDENCE, LOUISVILLE

a height of about 6', with a 16-in. projection, a molded nosing and dentils, supported on two scroll brackets, one at each end, with 5-in. faces. Two feet below this top shelf, resting upon a projection of the fireplace itself from the chimney-breast, is a second shelf, 6" deep and 5' long. These shelves were cast in place, and the mantel, like that in the Vaughn house, is finished in spatterdash stucco, uniform with the house and the living-room finish.

The living-room in which the mantel is located opens at one end into a pergola, about 18' long, the beams of which are supported on six large concrete columns, three on each side.

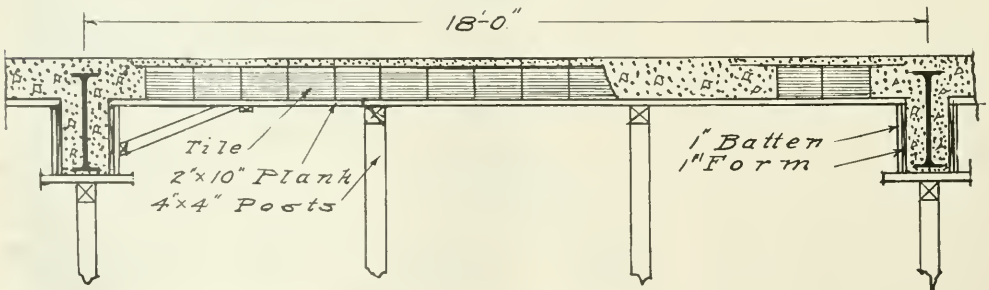
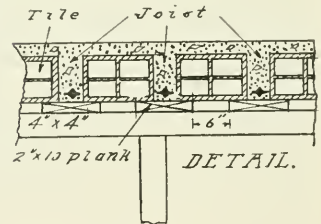
These columns are 8' high, and are somewhat heavier than those used in the Vaughn pergola, ranging from 18" in diameter at the base at grade to 16" at the top. They were started 7' below the present grade, as that portion of the lot is made ground, and it was considered desirable to go down to the original grade. These were cast in place, metal forms being used, and are reinforced each by a 1-in. center-rod. This and other concrete work in houses handled by Mr. Smith was done by Philip Leth, a Louisville workman of Austrian birth, who has specialized in ornamental concrete, and has secured some excellent results.

Centering Without Joists for Tile and Concrete Floors

Economical centering for floors where tile are used as cores is always an interesting problem. On some work recently completed in Detroit, the somewhat radical method was adopted of doing away with joists and using heavy 2-in. x 10-in. decking. The accompanying sketch shows the essential arrangement here.

It was a fireproof job where heavy 2½-in. I-beams were 18' o. c. After putting the bottom board for the girders, supported on 4 x 4's in the customary manner, and using girder sides of 1-in. sheathing with batten strips, the rather unusual practice was followed of doing away with joists and using 2-in. x 10-in. planking for decking. This decking was carried on two 4-in. x 4-in. stretchers placed at about the third points, that is, approximately 5' 8" o. c. The 2-in. x 10-in. timbers were placed with a 6-in. opening between them, the tile being placed directly over the opening. The reinforced concrete joists were 4" wide and total depth of the concrete T-beam was 10".

There was a 2-in. covering used on the tile. The engineer in charge of this work stated that the method worked out very well indeed. It is always more or less of a question as to whether the decking should extend over the top of the beam sides or butt against the side of the beam. On this work the superintendent stated that the 2-in. x 10-in. timbers would spring down so that there was no difficulty with end wedging.



SKETCH SHOWING ARRANGEMENT OF CENTERING WITH 2-IN. SHEATHING AND NO JOISTS



FIG. 1—RESIDENCE IN KANSAS CITY, MO.



FIG. 2—PEORIA, ILL., HOUSE

Advancing the Architectural Appeal of Concrete Wall Units

It is seldom that CONCRETE-CEMENT AGE feels that its readers are especially interested in a selling campaign adopted by the producers of any kind of equipment used in the concrete field, yet in connection with the wall unit here illustrated there is something to be said about the method of marketing the equipment and the material because to it attaches something fundamental in the development of concrete block to the best advantage.

The block shown in the illustrations is Hydro-Stone. That is purely a trade name adopted to designate the particular product made on the equipment which is marketed by Barron & Harridge.¹ It is strikingly illustrative of the demand of the industry that the firm of Barron & Harridge has been meeting with considerable success in addressing itself mainly to architects and to builders, rather than to manufacturers of concrete products with the idea of making a place for a material before producing it on a large scale. The Hydro-Stone equipment is an outgrowth or development of the Ferguson system of concrete block manufacture, and the efforts of Barron & Harridge have been particularly in the direction of emphasis upon the demands of architects and builders, and starting with a unit which the firm had reason to believe would appeal to architects for its structural nature, a great deal of attention has

been given to the production of wall units with architectural value. At the Chicago Cement Show the attention of hundreds of architects was drawn to specimen walls and specimen block after the Hydro-Stone system in the exhibit not only of the representatives of the equipment but also in the exhibit of the Universal Portland Cement Co.

SPECIAL FACING MATERIALS

Attention was drawn in the first place by surface qualities which had great variety. Block were shown in soft tones with facings in yellow, a wide range of grays, reds, browns and mixed tones. These effects were not produced by an elaborate or ex-

pensive method but simply by washing down the block and rubbing with a fiber brush, using only water in the operation. The effects are made more striking and more colorful by the use of acid in the water, but this is not required to give most satisfactory results. Beautiful as a gray granite faced block may be, it has until very recently represented the chief display of concrete block makers, in the line of special facings, with the exception, of course, of various sand facings in different colors. Much of the faced block which has been on the market has been conspicuously smooth and with a monotone over its entire surface. This may or may not appeal to individual tastes, and the whole matter of interest in the methods used by Barron & Harridge to bring Hydro-Stone before the public is simply in the fact that there has been recognition of the variety of tastes of individual architects, builders and home builders for such color



FIG. 3—RESIDENCE IN EVANSTON, ILL.

¹Insurance Exchange Bldg., Chicago
April, 1914

and texture qualities as can be had in the best qualities of clay face brick. The examples of especially faced concrete block shown make it plain that the possibilities for color values are much greater in concrete block than in brick and that units, from a purely architectural and not merely from a structural standpoint, will appeal very strongly to a great many people. Knowing that there is a very great interest now in the subject of special facing materials in the development of units which will have a wide appeal, we are publishing here a list of the sources of special facing aggregates and of the aggregates themselves:

Source.

Crown Point Spar Co., Crown Point, N. Y.
Monarch Mining Co., Jersey City, N. J.
Conlin & Co., Tuckahoe, N. Y.
Wisconsin Granite Co.,
Chamber of Commerce Bldg., Chicago, Ill.
Wausau Quartz Co., Wausau, Wis.
Marathon Granite Co., Wausau, Wis.
Ottawa Silica Sand Co., Ottawa, Ill.
T. S. Silica Sand Co., Ottawa, Ill.
Robt. Rossman Co.,
21 E. Van Buren St., Chicago, Ill.
The Ohio Marble Co., Piqua, O.
Zerbe Marble & Granite Works, Houston, Tex.
Moore & Co., Dallas, Tex.
James Henderson, Fort Worth, Tex.
J. B. Huffman, Fort Worth, Tex.
David Hughes, Fort Worth, Tex.
U. S. Construction Co., Fort Worth, Tex.
Marbleoid Co., Marbleidge Bldg., New York City
Pompton Pink Granite Co., 300 Fifth Ave., New York City
Peekskill Quartz Co., Box 135, Peekskill, N. Y.
The Texas Mica Co., Inc., Pecos, Tex.
U. S. Mica Mfg. Co., Chicago, Ill.

Material When Known Definitely

Micaspar crystals
Pure black mica
White crushed granite
Tuckahoe marble

Red and black granite
Very light quartz
Red granite
White silica sand
White silica sand

Various colored marbles
Verona yellow marble
Crushed marble

ROUGH TEXTURE

Instead of smoothness a great many people find a very rough texture attractive, and probably few concrete products manufacturers fully realize the architectural value of a wall unit with a very bold and coarse surface texture. Facing materials are almost always used fine so that the texture is close, and when in the wall give it only one tone. By leaving out the sand, or much of the sand, or the other very fine material, and by mixing up coarse particles with Portland cement and afterward cleaning off the surface film of cement, a deeply pitted and honey-combed surface is obtained which weathers well and gives a variety of color and tone.

Figs. 1, 2 and 3 show the use of Hydro-Stone in residence construction. Fig. 1 is the home of C. P. A. Clough, Kansas City, Mo. This house is built with the block of the upper walls having a face of Carthage limestone screenings and white cement, the face in this case being left just as it came from the machine without washing. This is a large house and cost about \$20,000. The illustration shows the block well

laid up, which is a very important item, and the architectural lines seem particularly well carried out in the wall unit which has been utilized—in other words, the unit is suited to the particular style of architecture, and vice versa.

Fig. 2 is a detail of the residence of A. P. Colvin, 300 Parkside Drive, Peoria, Ill., F. W. Klein, archt. This house cost approximately \$6,500. The block used in the foundation and with particularly good effect around the front doorway, are granite faced, the facing being washed. The other block are faced with white marble and white cement.

Fig. 3 is a house in Evanston, Ill.,

block being faced with lake sand and ordinary cement, the general tone being much the same as that of Bedford stone.

Fig. 4 shows two details at wall surface of the Normal Park M. E.

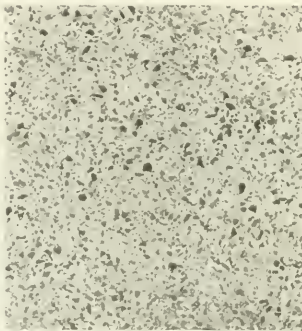


FIG. 6—DETAIL OF MICA SPAR FACING

church, Chicago. These block were faced with Wisconsin Granite Co.'s Utley black granite, graded from dust to 1½" in size, mixed with about

²Wisconsin Granite Co., Chamber of Commerce Bldg., Chicago



FIG. 4—DETAIL VIEWS OF NORMAL PARK M. E. CHURCH, CHICAGO

20% of micaspar crystals and used with Universal Portland cement. The light trim has a face of Wausau quartz,³ silica sand and Atlas white cement. All of the units are of Hydro-Stone except the large trim members and the window detail. The lower course of block is 12" high and the courses above are 9".

Fig. 5 shows a rough plain block quite suitable for warehouse or factory construction, or for making an excellent wall for residence construction.

³Wausau Quartz Co., Wausau, Wis.

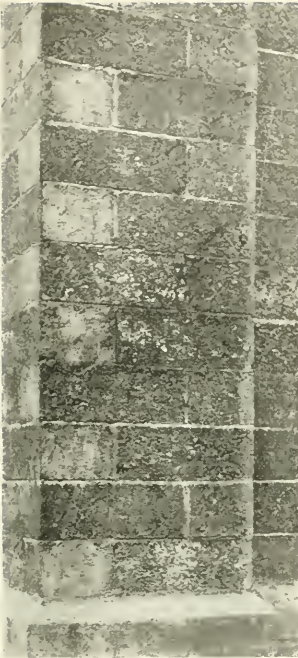


FIG. 5—ROUGH BLOCK FOR STUCCO

tion where stucco is to be used. The detail in the illustration is from the building of the Elgin, Joliet and Eastern Ry. Co., Joliet, Ill.

Fig. 6 is from a close-range photograph of a block faced with miscaspar crystals.

Fig. 7 shows a plan view of a block used in two-piece wall construction. In order that the nature of the concrete and the structure of the

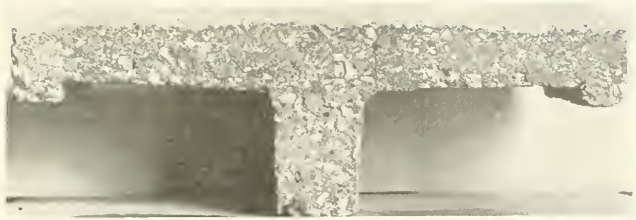


FIG. 7—SECTION OF CONCRETE BLOCK FOR TWO-PIECE WALL

block itself might be shown more clearly, the edge of this block has been washed with acid, removing the film of cement, showing the aggregate which is graded from $\frac{3}{4}$ " down; and along the top of the plate will be seen a lighter streak which marks the thickness of the face material. The illustration serves in this connection to show how the facing is bonded in the backing of the block.

Fig. 8 shows a corner of a wall being built up with two-piece block, and the view shows the horizontal continuous air space as well as the vertical air space; illustrates the header and stretcher bond and the method of turning the corners. The first course shown in this view is 12" high and the upper ones are 9" high.

Fig. 9 shows the machine in which the block are made together with an assortment of the various cores, fillers, dividers and so on, used in the mold box to produce various units. The mold box, fitted with cores and fillers, is filled with wet concrete, and then run under the press, which densens the wet mixture and forms a true face with perfect edges, and makes possible its immediate removal from the mold box. The releasing stand is raised to meet it and the block, supported on the pallet, slides face down from the mold and is im-

mediately carried to racks or cars for curing.

For a faced block, the operation is the same, except that the mold is filled to within $\frac{1}{4}$ " or $\frac{1}{2}$ " of the top and the facing material added. Pressure is then applied, bonding the face to the body.

For two-piece walls block are made in T-shaped units so laid up as to break joints alternately back and front and to give continuous air spaces in all directions, aggregating 50% of the wall volume. With this construction, plaster is applied direct to the inside wall surface. Two-piece walls range in thickness from 6" to 17" and by doubling up the units, can be used for construction even heavier than 17-in. walls. The one-piece block has two long webs instead of one, so laid up as to break joints and to give walls from 8" to 12" in thickness. Instead of putting in wall plugs to which to nail furring strips for the lath on the inside, it is proposed to use wire clips simply by putting in a U-shaped piece of wire into the mortar joint with the ends projecting. The furring strips going vertically on the webs are held in position by twisting the ends of the wire together. Wooden lath may then be nailed to the furring strips; however, the furring

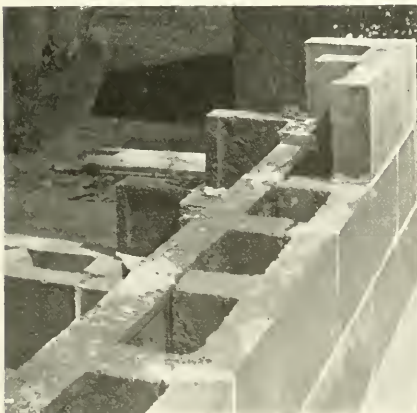


FIG. 8—TWO-PIECE WALL UNDER CONSTRUCTION

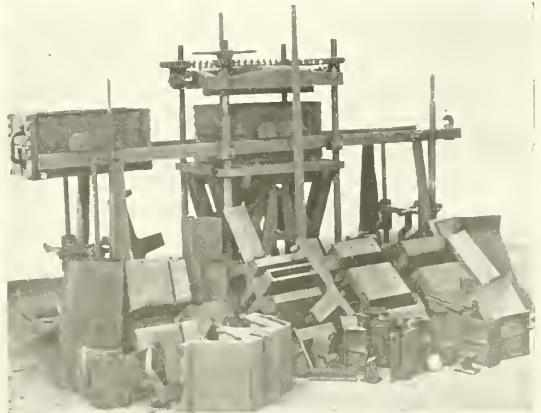


FIG. 9—MACHINE FOR MAKING HYDRO-STONE

strips might be eliminated and a better construction obtained by attaching ribbed metal fabric with the ribs running horizontally across the webs, and held in place as the furring strips are, by the wire loops.

There is a large plant now in operation at Mooseheart, near Aurora, Ill., where the order of Moose is conducting very extensive building operations in establishing a home for widows and children of deceased members. The operations now under way involve the expenditure of about \$500,000 and will ultimately require several million. This block is also being used in buildings being erected by the Minnesota Steel Co., Duluth, both for residences and for factory structures, some of the factory buildings being already erected.

To Give Mile of Concrete Road to County

Approximately one mile of concrete road will be built by the Marquette Cement Mfg. Co., Chicago, from Shippingsport bridge up Shippingsport Hill, La Salle county, Ill., without any expense to the county. The offer was unanimously accepted by the Board of Supervisors. The cement company proposes to cut down the present steep grade of 12% very materially, which will necessitate the moving of many thousands of yards of dirt. The full width of the road will be concreted. This work will be done free of all cost to the state, county or township, the Marquette company bearing the entire expense of grading, labor and all materials. The improvement will entail an expenditure of from \$14,000 to \$15,000. This pavement will connect with the concrete boulevard known as the La Salle-Oglesby Concrete Highway, a large part of the expense of which was borne by the Marquette company last summer. The grade on the Shippingsport hill at the present time is very steep and the condition of the roadbed makes it almost impassable for vehicles.

A Cathedral in British Guiana

Vice-Consul Lester W. Collins, Georgetown, British Guiana, writes in a recent issue of the *Daily Consular and Trade Reports* that a cathedral is to be built in Georgetown, of reinforced concrete at an estimated cost of about \$150,000. The building will require about 300 tons of reinforcing steel.

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa.

American Highway Association, J. E. Pennybacker, Jr., Secretary, Colorado Bldg., Washington, D. C. Convention, Atlanta, Ga., Nov. 9-11.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention, Chicago, December. (Definite dates to be announced later.)

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co., 72 West Adams St., Chicago, Ill.; J. P. Beck, Sec.

Interstate Cement Tile Manufacturers' Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. P. Beck, 72 W. Adams St., Sec.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

American Road Builders' Assn. Officers and Convention

At the annual meeting of the American Road Builders' Association for the election of officers and directors there were elected:

President, W. A. McLean, Commissioner, Department of Public Works, Toronto, Ontario, Canada; first vice-pres., Geo. W. Tillson, Consulting Engineer, Borough of Brooklyn, N. Y.; second vice-pres., A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Sacramento, Cal.; secretary, E. L. Powers, Editor *Good Roads*, N. Y. C.; treasurer, W. W. Crosby, Consulting Engineer, Baltimore, Md.; Directors for three years—Samuel Hill, President, Washington State Good Roads Association, Seattle, Wash.; Paul D. Sargent, Chief Engineer, State Highway Commission of Maine, Augusta, Me.; A. H. Blanchard, Professor of Highway Engineering, Columbia University, N. Y. C.; R. H. Gillespie, Chief Engineer of Highways, Borough of the Bronx, N. Y. C.; Harold Parker, Ex-Chairman, Massachusetts Highway Commission, Worcester, Mass.; Fred E. Ellis, Manager, Essex Trap Rock & Construction Co., Peabody, Mass.

The reports of the Executive Committee, the Secretary and the Treasurer were presented. These reports showed a large gain in the active membership of the Association, while the financial condition was found to be very satisfactory. Altogether the work of the Association during the past year has been the most gratify-

ing in the history of the organization.

At a meeting of the directors it was decided to hold the 1914 convention in Chicago early next December.

American Highway Assn.

The fourth American Road Congress, and the convention of the American Highway Assn., all its affiliated organizations, and the American Automobile Association, have been scheduled for Atlanta, Ga., during the week beginning Nov. 9, 1914.

It is also announced that in addition to the road organizations, committees of the American Bar Association and the American Bankers' Association would work in conjunction with the American Highway Association to make the fourth road congress crystallize the movement for more uniform road laws and a better system of financing road improvement throughout the country.

This will be the first meeting of the American Road Congress in the South and is a recognition of the great energy and progress that has been made in that section in the movement for improved roads. In 1913, about \$40,000,000 was expended by southern states on their public roads, in addition to the labor of thousands of state convicts. Georgia alone had her entire convict force, numbering nearly 5,000, engaged in road construction.

Plant Exclusively for Manufacture of Fence Posts

An interior view of a concrete products plant devoted exclusively to the manufacture of fence posts, is shown in Fig. 1. This is the plant of the National Staple Post Co., Westerville, O., and is practically the parent plant using the R. B. Bennett patents and process which are controlled by the Staple Post Mold Co., Westerville. This is the post into which staples or nails can be driven.

The equipment of the plant is simple and the operations are chiefly in two parts: first, assembling the reinforcing—an operation which occupies but a small space, and second, making the posts themselves. The line post is triangular in section with rounded edges and the reinforcing rods are held in place by means of spacers stamped out of thin metal. The spacers are shaped like the letter "V" and have holes stamped out at the apex and at the ends to receive the rods. The spacers are held in position by being set into slits sawed in a 2" x 4" on a horse-like frame. The hole at the bottom of the spacer projects at the top of the frame and the other two holes at the sides. The reinforcing units are quickly assembled and piled up where they are in easy reach of the man molding the posts.

The metal molds nest conveniently and are also within easy reach.

The mixer used in the Westerville plant is a Gaunt No. 3. The 1:1½:

1½ mix of cement, lake sand and limestone is run quite wet into a box at the end of the trough, as shown in Fig. 1, and is scooped up by the man making the posts. Usually six molds are racked at one time and when each has been filled to within half an inch or so of the top, a

special tool is used for placing the composition material which forms the nailing strip in one side of each post. This tool is essentially a trough 5' long (the length of the nailing space) and is so made that the bottom of the trough is closed when it is inserted down into the center of



FIG. 2—TAKING CAR OF POSTS FROM STEAM ROOMS



FIG. 3—YARD OF WESTERVILLE PLANT



FIG. 1—INTERIOR VIEW OF STAPLE POST MOLD PLANT AT WESTERVILLE, O.

the post being molded. The top of the trough is wide so as to receive the special mixture and when the trough is filled, the mixture is tamped into place by means of a strip of metal which is inserted at the top of the trough throughout its length. When forced down this long tamper opens the trough at the bottom, forcing back the concrete and making way for the mixture which forms the nailing strip. The operation itself is much more rapid than its description. When filled, the molds are set in a rack on a car as shown in the illustration. At the Westerville plant they are piled in eight tiers as seen in Fig. 2, where a car is being removed from a steam curing room.

There is one item of equipment not shown in the illustration—a vibrating framework to support the molds while being filled, which obviates any necessity for puddling of the concrete to get density. This was not in use when the photograph was made.

A 4 h. p. Cook² motor drives the mixer. Two bbls. of cement and 1 yd. of aggregate make 72 line posts 7' 6" in length. Line posts may also be made in any other lengths. In section, line posts are 3½" x 3½" x 4½". Corner and gate posts are made in various sizes, principally 6" x 8" x 9' and 8" x 10" x 9'. A line post weighs only about 50 lbs. One man's record at the plant is 279 posts in a day. Posts are left in the steam rooms 48 hrs. and are then stacked or piled in the yard. Fig. 3 is a view of the yard at Westerville and Fig. 4 shows a fence of staple posts.

The Westerville plant operates most of the year, using more than 1,200 line molds with many sizes of corner post molds. Mr. Bennett began the manufacturing but the business grew so that the National Staple Post Co. was organized, so that Mr. Bennett now gives his time to the Staple Post Mold Co. which equips other plants.

²Cook Motor Co., Delaware, O.



FIG. 1—USING A FIELD-MADE PLATFORM

Using Hand-Power Hoisting Rigs for Small Work¹

By C. D. GILBERT²

Construction jobs divide into three types. First, the large building where power for the hoisting is available; second, the small job where power is available, but where it would not pay to set up as elaborate a rig for hoisting as on the larger jobs owing to the small amount of material handled; third, jobs large and small where concrete must be hoisted by hand.

On the jobs of the first class a regular elevator may be installed as is done for any large job of concrete construction work. As a suggestion, Fig. 1 shows a hoisting arrangement which was used on a large school building for the Berkshire Industrial school, Canaan, N. Y. This was operated by the drum on the little batch mixer shown at the right.

In this case a run was built from the mixer platform through the wall where there was a door opening. A car was made running on small

¹These notes are abstracted from a booklet on concrete wall construction about to be published by the Van Guilder Hollow Wall Co., Rochester, N. Y.

²See Van Guilder Hollow Wall Co., Rochester, N. Y.

wheels which would readily carry six pails of concrete and return by its own weight. This rig is very similar to the inclined railways such as are found in Pittsburgh and Quebec.

On some jobs a cable with trolley pulleys can be substituted as shown in Fig. 3. The pulleys should be about 10" in diameter in order to have the hoist work nicely. This is essentially an inclined trolley or cableway hoist, and under many circumstances should prove very economical.

[Editor's Note—The reader may be interested in comparing this rig with the inclined wire used for silo construction by H. A. Rogers, near Johannesburg, South Africa, as described on p. 16 of the Jan., 1914, issue. In this work the empty pails were slid back to the ground on an inclined wire.]

A HOME-MADE PULLEY

In a great many cases, however, hoisting machinery is not available or the job is so small that it would not pay to install either of the foregoing methods. We believe, therefore, that the details of an inexpensive rig which was recently used on a comparatively large building, and

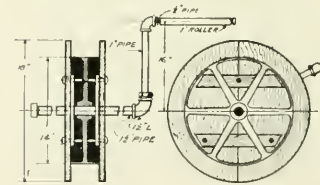


FIG. 2—A FIELD-RIGGED DRUM FOR A HAND HOIST

with which was hoisted by one man without difficulty as much as 10 cu. yds. of concrete per day, will be found useful by many builders. The materials for this can be found on any farm or around any factory or junk heap, and the work of making it will require but a short time.

Secure a pulley from 12" to 16" in diameter (14" is best) and mount it on a piece of pipe for an arbor. The 1½-in. pipe approximately fits a 2-in. hole in the pulley. The pipe should be threaded on both ends, and a crank built of pipe and fittings as shown in the drawing, Fig. 3. Make two flanges of wood about 6" larger in diameter than the pulley used. Cleat them so that the cleats will come inside the rim of the pulley. Bolt on to each side of the pulley as shown. If there is danger of the pulley turning on the pipe it is well to drill a hole through the pipe and put a pin through it, fas-



FIG. 4—FENCE OF STAPLE POSTS

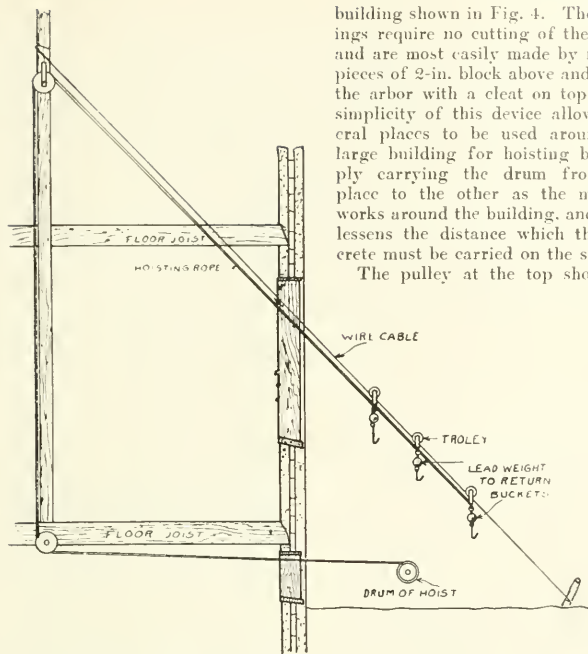


FIG. 3—SKETCH SHOWING ARRANGEMENT OF AN INCLINED CABLEWAY FOR HANDLING PAILS OF CONCRETE

tening it securely to the wood flange. This drum should be mounted on two pieces of plank leaning against the

large and run easily for the best results. This is an especially good rig for silo work.



FIG. 4—USING A HAND HOIST AND PAILS TO RAISE CONCRETE

April, 1914

Mythical Stories of Early Stone Making

In the first issue of the *Medusa Review*, a bulletin published by the Sandusky Portland Cement Co., the significance of the trade name "Medusa" as applied to Portland cement is explained. As the legend of mythological activity in making artificial stone it may be of interest here:

The goddess Athene, it seems, becoming enraged at the beautiful Medusa, changed her into a Gorgon, a monstrous woman-creature with snaky locks, a look into whose face turned the beholder into stone. Perseus, son of Jove and Dana, by command of the wicked King Polydectes, and provided by Hermes and Athene with winged sandals and a helmet of invisibility, cut off the head of the Gorgon, avoiding her fatal eyes by looking only at her reflection in his shield. On his homeward way he rescued from a sea monster the beautiful maiden Andromeda, turned the giant Atlas into a mountain, and at last punished Polydectes and his counsellors by showing them the head of Medusa, which changed them to stone images.

Medusa was the earliest known maker of artificial stone and her likeness has been appropriately adopted as the trade mark of one of our well-known American Portland cements.

CONCRETE-CEMENT AGE.

Statement of Ownership, Management, Etc., of Concrete-Cement Age,

Published monthly at Detroit, Michigan.
Required by Act of Aug. 24, 1912.

General Manager, Walter C. Boynton;
Business Manager, R. Marshall;
Consulting Editor, Robert W. Lesley;
Managing Editor, Allen Brett;
Associate Editor, Harvey Whipple;
Publisher, Walter C. Boynton;
Owner, Concrete-Cement Age Publishing Co.;

Stockholders (holding more than 1% of total amount of stock):

Walter C. Boynton, 71 Atkinson Ave., Detroit, Mich.;

Robert W. Lesley, Haverford, Pa.;

Edward B. Bruce, Manila, P. I.;

Gillespie Bros., Inc., Stamford, Conn.;

F. F. Lincoln, 30 Church St., N. Y. C.

Roy Marshall, 27 LaSalle Gardens N., Detroit, Mich.

Allen V. Brett, 32 Stimpson Place, Detroit, Mich.

There are no bonds, mortgages or other securities outstanding against the corporation.

WALTER C. BOYNTON,
General Manager.

Subscribed and sworn to before me, a Notary Public in and for the County of Wayne, State of Michigan, this 1st day of April, A. D. 1914.

ROY MARSHALL,
Notary Public.

(My Commission expires Feb. 3, 1917.)

New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

New Automatic Tile Machine

The accompanying illustration shows the new "Automatic" tile machine of the W. E. Dunn Mfg. Co., Chicago.

What it does and how it does it are perhaps best told in the description given by the manufacturer:

A one-sack batch of concrete is discharged from the mixer into the lower hopper, the top of which is only 12" from the ground. The bottom of this hopper moves automatically back and forth, agitating the concrete and discharging a definite quantity into the elevator boot. Be-

tween the hopper and boot is an adjustable slide, permitting the quantity of material passing through to be regulated in accordance with the size of tile being made.

From the boot the concrete is carried by the buckets of an endless chain elevator and discharged into the hopper above the machine. Below this hopper is a box which receives sufficient concrete for one tile, which slides forward and discharges its contents into the empty casing and onto the packer head.

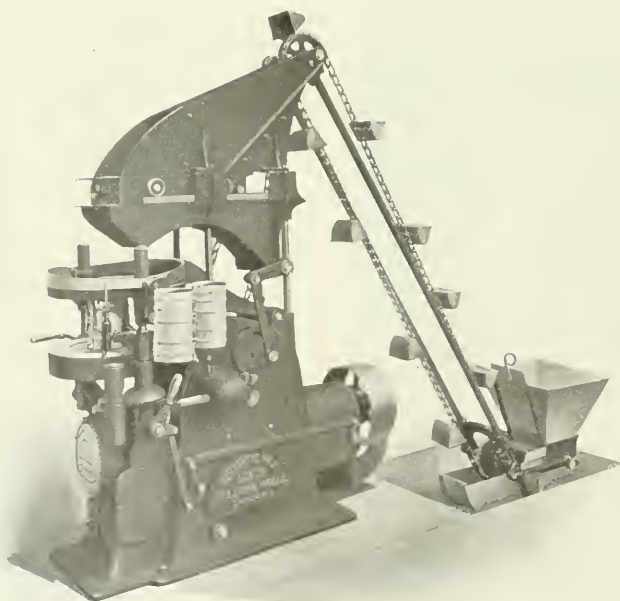
While this operation has been in progress, the casing carrier has automatically placed and locked an

empty casing in position, and the packer head has come from below and formed the floor of casing. The movements are so timed that the concrete falls into the casing at the exact moment the casing and packer head are ready to receive it. The actual operation of packing now begins.

The first 10 revolutions of the packer head pack the bottom of tile. Then it starts upward, forming, troweling and packing the tile until it reaches the top, when it returns. On its downward journey it smooths and refinishes the tile and imparts a distinctive glaze to the inside. As soon as the packer head reaches the bottom, the top ring automatically rises, releasing the tile for removal. While the finished tile is being removed another casing is being automatically placed in position, permitting the work to proceed without interruption. The packer head makes 40 revolutions on its up stroke, 20 revolutions on its down stroke, so that each tile is of uniform density from bottom to top.

Every movement of the "Automatic" is under control by means of friction clutches operated by levers located within easy access of operator, so that individual movements can be operated independently of others when desired. Some of the movements are continuous, others are intermittent, the latter being accurately timed to operate at the exact moment necessary and in perfect unison with the others.

The machine itself is started and stopped by friction clutch pulley operated by the lever on right hand side of machine. At the left is a lever which controls or stops the up and down motion of the packer head shaft, casing carrier, feeding or elevator. Another lever, also at the left of machine, controls the elevator and hopper independently of the ma-



DUNN NEW AUTOMATIC TILE MACHINE

chine. There is also a set of back gears permitting the machine to be run at slow speed without changing the speed of the engine, which is very desirable when making large tile.

This casing carrier holds four casings and its operation is intermittent. The moment a finished tile is removed from machine, the carrier makes a quarter turn, placing an empty casing in position to receive the top ring, which locks it securely. The carrier remains stationary until the tile is completed and removed, when it repeats the operation. This casing carrier is intended for use when making tile up to 8" in diameter. When making large tile the machine runs at a reduced speed, allowing ample time for the casings to be placed in position by hand.

The machine is furnished without the casing carrier, feeder, elevator and hopper. Some plants are equipped with the mixer overhead so that the mixed concrete can be discharged directly onto the table of the tile machine.

Concrete Distributing Equipment for Silo Construction

A concrete distributing system for concrete silo work has been developed and put on the market by the Reichert Mfg. Co., Milwaukee, in which the hoisting equipment consists of a vertical A-frame resting on short

pieces of angle-iron, laid across the top of the forms. A horizontal angle iron extends from the center post and passes out over the A-frame about 3' past the face of the silo. On this horizontal stringer, a trolley is placed to which is fastened a pulley block.

In handling concrete, two specially built pails are used, holding 2 cu. ft. apiece. One pail goes up full while the other comes down empty. When the full pail of concrete reaches the top, the trolley is pulled in toward the silo and placed on a specially built carriage which can be described briefly as follows:

The carriage is a horizontal A-frame with its apex pivoted at the center, and its base supported on wheels which run on a track laid parallel to and inside of the molds. The pails are fitted with trunnion lugs a little above center, and the traveling carriage is fitted with a frame in which the pails can be swung, supported by these trunnions.

After a full pail is pulled up, the trolley is pulled inward, and the pail, supported on trunnions, placed on the carriage. It is then a very easy matter to rotate the carriage and dump the pail at any desired point. The accompanying illustration shows the essential features of this arrangement.

While this rig was developed for silo construction especially, there is no reason why equipment built on similar lines can not be used for the straight walls used in house construction.

Chain Belt Paving Mixer

The accompanying illustration shows the latest development in the construction of a paver by the Chain Belt Co., Milwaukee.

The drives on the Chain Belt Paver, with the exception of the boom and bucket, have heretofore been of Chabeleo steel roller Chain Belt. This year the steel Chain Belt drive is placed on the boom and bucket as well. The paver attracts particular

attention, due to the fact that the levers are all on one side of the paver, so that one man, standing on the platform, can operate the machine. The levers are so arranged that they are operated in a natural sequence.

The power plant has more than enough power necessary to operate the paver, and the drives for propelling the paver and revolving the drum are split so that when the paver is moving along on its own power the drum does not revolve.

The machine is built strong and compact to enable it to operate under the most severe conditions.

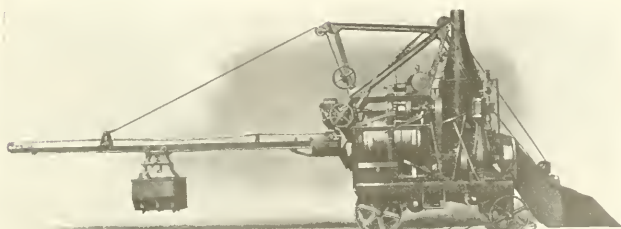
New Molds for Wet Process Block

The accompanying illustration shows a recently developed outfit, very simple in form, particularly for the manufacture of wet process block. This is introduced by the Hotchkiss Lock Metal Form Co., Binghamton, N. Y. While the accompanying illustration shows an outfit in use, making plain block, very similar outfits are made for well curb, silo and other special block, and still another outfit, alike in principle, is made for the manufacture of fence posts with square sections.

The side forms and dividing places are assembled resting on 2 x 4's with bedding of sand between, the sand to take care of excess moisture in the concrete. The illustration shows the operation of making block after this new wet process method. A small perforated spade is used with a tamper on the other end of the handle, and this is the only tool required besides the shovel or whatever device is utilized to convey the concrete into the molds. The perforated end of the tool is used to press the coarse mixture from the face of the block, allowing the fine mortar to come to the surface to make a fine, smooth texture, while the tamping end is used for what-



HOISTING AND DISTRIBUTING RIG FOR CONCRETE SILO CONSTRUCTION



CHAIN BELT PAVER

or small amount of tamping may be required. With an outfit of this kind 15 block, 8" x 8" x 16" can be made in one set; 12 block, 8" x 10" x 20" or 10 block 8" x 12" x 20" in other sets. The outfit for block 8" x 8" x 16" consists of two side rails, 7 $\frac{3}{4}$ " wide by 10' 2" long, so cut as to receive 16 dividing plates to make 15 block. The block have



FILLING BLOCK MOLDS

two air chambers which are formed by 30 galvanized metal tubes with wire frames to hold the tubes in position while the concrete is shoveled in. Ten-in. block 20" long are made with an outfit having two side rails 7 $\frac{3}{4}$ " wide x 10' 2" long, and the 12-in. block can be made with the same forms, providing the side rails have been so slotted as to receive the dividing plates at the 12-in. spacing.

Concrete Roof Tile Machine and Product

Some recent tests and uses of concrete roofing tile serve to attract attention to the concrete roofing tile machine of Otto Walter, De Kalb, Ill. While this is not entirely new, Mr. Walter has been improving the machine for several years and it is at present built as shown in Fig. 1, with cross-section showing how the roofing tile lay up and interlocking at the side joints shown in Fig. 2. The machine itself is a simple outfit. The operator places the pallet or base into the machine; turns a crank at the right so as to lift the pin which leaves a hole in the tile; then fills the mold with concrete; tamps it firmly; forms a corrugated surface with a tool for that purpose; sprinkles the surface with a fine mixture which may or may not contain a special color; using for this purpose a hand sieve. The surface of

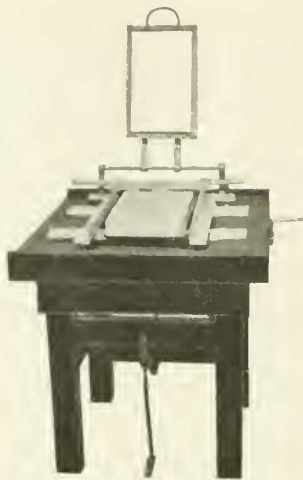


Fig. 1

the tile is gone over with a smoother; the crank at the right of the machine is then reversed, lowering the pin, and then by a movement of the treadle, the finished tile is released resting on the pallet, so it can be set away on a rack to harden. A report of a test made by the Laboratory of Applied Mechanics, University of Illinois, for Mr. Walter, is as follows:

TESTS OF CONCRETE ROOFING TILE

Ten specimens of concrete roofing tile were furnished for test. Nos. 1 to 5 were red in color, and according to information furnished by Mr. Walter had been on a roof 4 $\frac{1}{2}$ yrs. Nos. 6 to 10 were gray in color, and were 3 mos. old at the time of test.

Permeability Tests—The permeability of the roofing tile was tested by closing the ends of the longitudinal channels in the top faces by means of plaster of paris, and filling the resulting cavities with water. Each of the ten tiles furnished was tested in this way by keeping the channels full of water for 19 das. None of the tile showed any indication of leakage or any moisture on the under side at any time during the test. The water lost by evaporation and absorption was replaced by filling the cavities about twice daily. It was noted that the red tile showed a much smaller loss of water than the gray ones, indicating that the water lost by penetration through the weather surface was much less in the red tile since the surface exposed to evaporation was the same in both tiles.

Transverse Tests—Transverse tests were made by supporting the tile on the four



Fig. 2

lugs near the corners of the under side and applying a load across the top of the tile at the middle of a 14-in. span. Cushions of leather belting were used at the

load point and at the points of support to give a more uniform distribution of

TEST OF ROOFING TILE

No.	Color	Maximum Center Load Pounds
1	Red	255
2	Red	275
3	Red	215
4	Red	285
5	Red	285
6	Gray	broken before testing
7	Gray	150
8	Gray	170
9	Gray	145
10	Gray	120

the load. The accompanying table gives the results of the transverse tests.

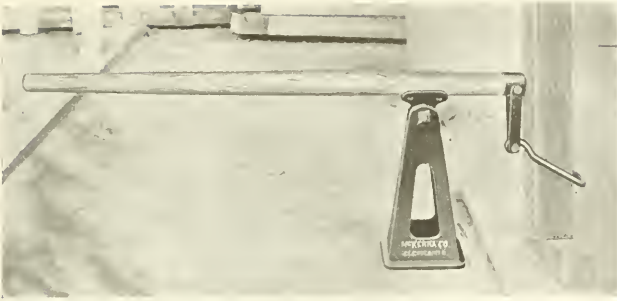
Self-Furring Metal Lath

By cutting rows of staggered short slots in sheet metal, and then expanding the sheet by pulling outwardly, and at right angles to the direction of the slots with the pull applied uniformly along the entire edge, alternate webs of the diamond meshes formed are buckled upward. This is the way the Sykes Metal Lath and Roofing Co., Niles, O., manufactures "Self-Furring" metal lath. This is a diamond mesh lath made in sheets 18" x 96" and in gauges 27 to 24. The process of slotting and expanding develops transverse ribs which, when the lath is applied, take the place of furring. This material is being widely used for "overcoating" work, etc.

Huntington, W. Va., is in need of an up-to-date concrete products plant to operate on a large scale. Huntington has a population of about 45,000. The Chamber of Commerce would assist in securing a site. Correspondence should be with R. L. Day, architect, and with H. E. Matthews, Secy. of the Chamber of Commerce.

On the engine housing of the batch mixer manufactured by the Atlas Engineering Co., Milwaukee, a rod support for a red lantern is placed which will hold a red lantern securely in place when it is necessary to leave the mixer in an exposed place at night.

The name of the Ambursen Hydraulic Const. Co. has been changed to the Ambursen Co., and former president, Wm. L. Church, has been succeeded by Charles E. Parsons. The general offices of the company have been moved from Boston to 61 Broadway, N. Y. C.



AN EFFECTIVE JACK FOR RAISING AND ADJUSTING CONCRETE FORM WORK

A Jack For Raising Center- *ing*

The accompanying illustration shows a lifting jack, which should find many uses on construction work. The essential features of the jack are shown in the illustration. It is designed especially for quickly adjusting the height of concrete forms. With this jack, the form can be quickly elevated to the desired height or level, and any required wedges and blocks placed immediately.

For handling panels or other construction units, the jack could be fitted with a toe lifting arrangement. This equipment is being placed on the market by the McKenna Co., Cleveland.

A Simple Builders' Hoist

Elevating materials is one of the fundamental problems of any construction work and the accompanying illustration shows a light, low cost hoist recently developed and put on the market by the Sioux City Engrg. and Machy. Co., Sioux City,

Ia. A vertical 2-h. p. gas engine is mounted at one end of a pair of skids 6' long, driven by a belt to a counter shaft (c).

The ingenious feature of this rig is the fact that the transmission is effected by a small leather friction wheel, 4" in diameter, in contact with a large iron friction wheel, cast with the cable drum. The operation of the hoist is controlled by the lever (l) operating the eccentric shaft (e) on which the drum rotates. A forward motion of the lever throws the friction wheels in contact and drives the drum. Pulling the lever back forces the iron fly wheel in contact with a fixed brake shoe, so that the drum is under control.

The hoist complete weighs 600 lbs. It is compact and should find many uses on the average job. Its capacity is 500 lbs.

Asbestos and Asphalt Roofs *for Modern Factories*

An interesting feature of the new South Works of the J. I. Case Threshing Mach. Works at Racine,

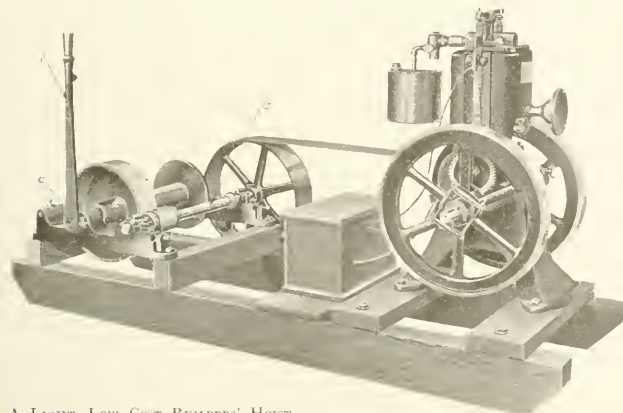
Wis., is the roofing, which is made of asbestos and asphalt. For roofing purposes the asbestos is made into a felt, layers of which are cemented together with asphalt. It is claimed that this roofing is proof against the action of chemical fumes, and that sparks and burning brands have no effect on it. The H. W. Johns-Manville Co., N. Y. C., which manufactured the roofing referred to above, states that this roofing is not affected by changes of temperature. The hottest weather cannot cause it to dry out, melt or run, and the coldest weather can not crack it.

A New Form Lubricant

Contractors are recognizing that it is economy to coat forms—either wood or metal—with some oily or greasy material which will prevent the concrete from sticking and to preserve the forms. The Richmond Screw Anchor Co., N. Y. C., is putting on the market "Risco" form lubricant, which is a grease used in the field by forming an emulsion with water. The manufacturer states that this will not stain the concrete surface and it will prevent the concrete from sticking to the form. This material is a solid substance about the consistency of lard. In use, it is mixed with water in the proportion of 1 lb. of compound to approximately 2 gals. of water. The emulsion is applied with a brush, rag or cotton waste.

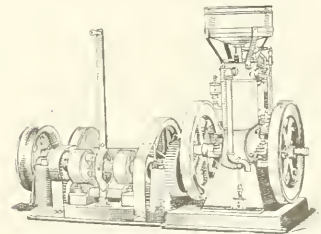
A Light Hoisting Engine

The hoisting engine shown in the accompanying illustration is built in five sizes, from 3 h. p. to 12 h. p., and is a small compact hoist designed



A LIGHT, LOW COST BUILDERS' HOIST

April, 1914



GENERAL VIEW OF LIGHT GASOLINE-DRIVEN BUILDERS' HOIST

for general building work. One hand lever operates both the direct and the reverse clutches, and the brakes are operated by a foot lever. Internal

clutches are used throughout, and all gears are machined. An interesting feature of this equipment is that it is a reversible gasoline-driven hoist. The Lansing Motor & Pump Co., Lansing, Mich., is the manufacturer.

Labor the Big Item in Concrete Construction

Building work is a proposition very similar to keeping store, or any ordinary jobbing proposition. A contractor buys so much cement, steel, aggregate, lumber and other miscellaneous articles and combines them into a building, which he sells to the owner. In a way, the labor is engaged in wrapping up the package, making it available for the owner. In general building work the engineer and owner do not sufficiently appreciate that the builder or contractor is largely a broker buying materials. With an office building,



CHART SHOWING SUBDIVISION OF CONCRETE ON REINFORCED CONCRETE BUILDINGS

for instance, the general contractor may not handle more than 10% of the contract price as direct labor. The rest is materials bought and sub-contracts let.

In reinforced concrete construction the percentage of labor is larger than in any other building operation. According to a statement by L. C. Wason,¹ in a recent address, the cost of labor on reinforced concrete building work averages about 35% of the cost. The contractor, therefore, realizes the necessity of a first-class purchasing department. Most manufacturers have such a department. Sometimes one and sometimes the other has much better facilities for obtaining the lowest price on materials required in construction. Therefore, the co-operation between the two departments produces the best result to the owner. A diagram of the results obtained on a typical reinforced concrete building is given to illustrate the important divisions of cost.

¹Pres., Aberthaw Const. Co., Boston



THE PAGEANT OF THE SUN GOD—A MURAL DECORATION IN ENCAUSTIC TILE

Possibilities of Mural Decoration with Inlaid Tile

Any true and permanent development in structural work must serve beauty as well as utility. Decoration of concrete wall surfaces has always been a fascinating problem, and the use of inlaid tile has received and has merited careful and sympathetic study. The accompanying illustration shows a striking use of large tile in mural decoration which might well be adapted to concrete surfaces. This panel and the general problem of the lack of color in modern architecture are discussed in the following paragraphs, by Charles De Kay, an art critic of N. Y. C. The panel is a bas-relief in enameled tiles recently shown at the exhibit of the Architectural League, N. Y. C.:

Notwithstanding all that has been done in the way of tiles to decorate the interior and exterior, the fact remains that our architects are not taking the advantage they might of this material to enrich the townscape and provide sumptuous and lasting color schemes for churches and capitols, hotels, libraries and railway stations, public and private houses.

The color notes from smooth or dull or unevenly surfaced products of the kiln have been so far mild enough, discreet enough, well enough suited to the timidity one meets when the question of color comes up. Even these anemic hues are often set aside for drab or dead white walls unrelieved by anything save windows in monotonous rows whose deadly iteration is tremendously tiring. By the deft introduction of tiles in smooth or dull glazes much might be done to render tall buildings less repellent, and to some degree disguise the enforced and ghastly regularity of the fenestration.

There are, however, bolder workers in the field for urban architecture.

At the exhibition in N. Y. C. of the Architectural League, one of the best in recent years, glazes are shown of great promise in a large mural panel or tablet, not composed of small cubes like mosaic, nor of tiles in formal squares, but of irregular pieces of faience. The effect of

the jointing suggests the so-called Cyclopean masonry of the early Greek period.

The theme chosen is that of Cacique priests in adoration of their gods. Worship of the old gods of the Incas, Mayas and other culture-tribes of South and Central America and Mexico may well be taken for compositions of great boldness and beauty, and particularly are they suited to tiles in relief. We may have here the beginning of a national style of decoration for large buildings.

Unlike much of the tile work made today, this design is carried out in singularly rich and harmonious tones. The artist has been inspired by that strong feeling for simple, broad color masses found in decorations that survive from the pagan past, but found also in textile and futile work of modern Indians.

Now the atmosphere of our cities, charged with chemicals, works banefully on ordinary pigments, but tiles with a well baked body and firm glaze withstand these acids as they do heat and cold, sunlight and frost. They give the least possible lodgement to the grime that floats in the air.

Tiling can be varied in tint to prevent a too solid color, it can be modeled in relief to obtain effects of shade. Chance alterations in tone, or "hazards" of the kiln allow the architect a gamut of color vibrations on which to play the changes. Such examples of American tile work are of happy augury, for they must mean that architects can obtain soft or bold effects of color if they want them. Perhaps through this material we shall have presently an architecture better suited to our brilliant atmosphere, our autumn woodlands, than the doleful kind we inherit from Europe. In the hands of architects who have some feeling for color we should have rich and varied decorations for school house and city hall, hospital and public library, clubhouse and theater, market and museum. We should demand to be at least favored in this way as were the men of the Middle Ages and the ancients of Greece, Assyria and Egypt when they built their temples and palaces.

Continuous Reinforced Concrete Pipe—Lock Joint Pipe Co., N. Y. C., 9" x 6", paper, 122 pp., illust. This is a comprehensive catalog describing in detail the uses of pre-cast pipe in 78 cities of the U. S., Canada and Cuba. Many illustrations are shown of interesting installations. The catalog tells its story mainly in pictures.

²Made by the Am. Encaustic Tile Co., N. Y. C.

Concrete-Cement Age

Vol. 4.

Detroit, May, 1914

No. 5

Special Mixtures for Special Results

SOMETHING which must be developed by manufacturers of concrete stone—developed until it is the general practice—is the choice of materials for concrete to give definite results—specified results, not merely in strength and impermeability but in color and texture. Specific results must be studied out and attained by experiment. There can be no hard and fast rule. The article by D. B. Adams—page 222, this issue—not only details each successive step in the production of the concrete statues for the Boston City Hall Annex, but it brings out the importance of special mixtures for the result desired.

The Need of the Small Mixer

IN an excavation for a big modern building there was noted, the other day, an illustration, striking, though negative, of the efficiency of the small batch mixer. In this big excavation there was standing in the center a big $\frac{3}{4}$ -yd. batch mixer. In one corner of the excavation, not 100' from the mixer, a dozen men or so were hand mixing concrete for the footings. It did not pay to bring the big mixer through the mud to run the footings, although they were big footings and the yardage was considerable.

The value of the light mixer lies in its ability to be brought to the spot where it is needed. On many big jobs, both large and small mixers are being used, the large mixer at a central plant and the small mixer to handle the preliminary work and the odd jobs.

Decorative Work

THE charge has frequently been made that concrete is too monotonous in color and texture for good decorative development. This magazine has presented descriptions of many pieces of work which show results which are quite the opposite in effect. A good idea of the variety possible is brought out in a description—page 216—of work done by Adolph Schilling on the estate at Rosemont, Pa., of Alba B. Johnson, president of the Baldwin Locomotive Works. Coupled with the

description of this particular piece of work is an account of the methods employed in securing effective coloring. Such results should give confidence to the architect in considering concrete in decoration and should spur the manufacturer of ornamental concrete to the production of artistic work.

What "Knockers" Often Get

THIS title is brought to mind in reading the following paragraph, which is a news item from a Minneapolis daily:

As a result of the controversy between dealers in corrugated iron and corrugated steel the Minnesota Highway Commission has recommended to town, city, village and county highway builders that they make culverts of neither material, but instead use concrete or cast iron. These are tried materials in this state. The pure steel men and the pure iron men criticised each other's materials so severely that the commission was afraid to recommend either.

It is rather amusing.

Making Concrete on Broadway

BROADWAY, the Great White Way of the metropolis, is famous for many things, but it has seemed to us in the past that it would be the last place to turn to for concrete plants. It is an old saying that seeing is believing, but of better application in this connection would be, "seeing is surprising."

A few weeks ago, one Saturday evening, on a walk from the Battery to 43rd St., the site of the Equitable building caught the eye. Here a vast pit, the base of a greater Equitable building, seemed one heterogeneous combination of mixer plants, timbering and runways. There were probably five individual concrete plants turning out concrete in that excavation.

Up the way a little, the old Astor house seemed cut in two, sawed right through the middle of the conventional Doric doorway, and, where the southern half used to stand, half cleared away debris only met the eye, but at the southern corner, concrete work was going on down below. The whirling grind of a mixer could be heard.

From here on, Broadway is the path of the new

subway. The street is a timber floor. Service pipes are along the gutter, or up in the air on frame work, and concrete in the making is everywhere in evidence. Up into the darkened and almost deserted wholesale section, every few blocks shows a concrete plant of some type. Here, in a side street, a few feet from Broadway, a small batch mixer is working under an arc light. A little further, a gang of men is hand mixing, using the wooden planking of the street as a platform. They are using frames to measure quantities, running two batches at a time, and shoveling mixed concrete through a 12-in. x 12-in. hole in the planking. It probably goes into a chute, to be carried directly into the forms of the subway walls or footings below.

With the room available, the two batches referred to were handled easily. One gang, with wheel-barrows, were wheeling up the aggregate, which looked like 2-in. screened gravel, the sand and the cement, and filling the forms, getting the batch ready, while another group was turning it over, wetting it, and shoveling it down through the hole.

A little further, almost to Wana-maker's, a big overhead bin structure indicated a central plant with probably a big mixer down nearer the subway level. Another block or so, and a little batch mixer with a side loader was drawn up on the sidewalk, indicated in the dim light by red lanterns "fore and aft." This was going into commission within a day or so.

At 23rd St., operations were reversed, and concrete in the unmaking was seen. Right at the intersection of Broadway and Fifth Ave., a construction building was placed, and here they were tearing up the pavement, a preliminary to the excavation and planking over. Here, over an area of about 200 sq. ft. the asphalt pavement had been ripped off, and, in shoveling courses, they were working on the concrete base and sub-base. This work will be covered in greater detail in a subsequent issue—but the method used consisted essentially of drilling holes with a pneumatic drill, 8" to 12" o. c. through the base, and 2 1/2" or so, o. c. in the sub-base, and driving wedge-shaped pins into these holes, breaking off the concrete in great chunks.

This ended the variety of concrete activities for Broadway that evening, but the walk was an interesting illustration of the way in which concrete making plants are adapted to different needs. With the exception of the Equitable building, all the plants were on the subway work, each type to its particular need.

Changes in Concrete-Cement Age Staff

JEROME COCHRAN, B. S., C. E., M. C. E., has joined the editorial staff of CONCRETE-CEMENT AGE. Mr. Cochran is a graduate of Cornell, with the degree of M. C. E., and has devoted the major part of his attention to concrete and reinforced concrete design and construction since 1902. He has had a wide experience in every branch of concrete work. His experience as a practical field man and an engineering expert is at the service of our readers.

Mr. Cochran is a recognized authority in his chosen subject and the author of several important text books. His "General Specifications for Concrete and Reinforced Concrete, including Finishing and Waterproofing" is a valuable contribution to the literature and his "A Treatise on Cement Specifications" is well known in the field. A third book is "A Treatise on the Inspection of Concrete Construction," which is full of meat.

Besides his text-books and his practical office and field work, Mr. Cochran has been a prolific writer in the engineering papers. He has contributed a total of nearly 50 articles on concrete in all its forms to the leading publications in the field and is a man of wide acquaintance with members of his profession. His name is already familiar to many of the readers of CONCRETE-CEMENT AGE, and it is believed that his contributions to this paper will increase its effectiveness as a means of service to the industry.

Allen Brett, for the last six years engaged in editorial work on concrete engineering in the magazines, has resigned as managing editor of CONCRETE-CEMENT AGE to join the staff of the *Engineering News*, N. Y. C. The hearty good wishes of his associates on this magazine go with him. Mr. Brett is well known in the con-

crete field. His earliest work of an editorial nature was done on *Concrete Engineering*, when that paper was published in Cleveland. When it was merged with *Cement Age*, N. Y. C., Mr. Brett assumed the duties of managing editor of that paper and when the consolidation between *Concrete* and *Cement Age* was made in June, 1912, he came to Detroit with the same title and duties.

Mr. Brett has youth, energy and boundless enthusiasm for whatever he undertakes. His education and experience have taken him into the fields of engineering and contracting and his editorial work has reflected the work that he has done in office and in field. He has many close friends in the industry and he has made many lasting friends for CONCRETE-CEMENT AGE in the two years of his service here.

Patented Processes

THE following paragraphs are from a recent issue of the *Engineering and Mining Journal*. Change "mining and metallurgical program" to "cement and concrete development" and we have a criticism of our own field which it is well to heed.

Contemporary technical literature leads us to the conclusion that the average engineer of the present day needs education of a kind that no school can furnish. When he finds something needed in his mining or metallurgical program, he invents it and goes ahead calmly, not bothering to find out whether or not anyone else had previously used the idea. When the inventive engineer considers his idea worth patenting, he usually learns much about the previous state of the art, and then strains his intelligence and that of his attorney in imagining reasons why he ought to have a patent on something that has evidently been thought of before. If he persists long enough, he usually gets his patent, a document which serves principally as a license to litigate.

Many an engineer needs more historical education. If he feels the need for a device to do certain work, he ought to investigate the technical literature of his subject and also the files of the Patent Office. In this way, he could learn many things of value to him, avoid going over ground that has already been explored, and possibly be better able to judge whether or not an invention is needed. Most engineers are only superficially acquainted with technical literature. Patents they consider a nuisance, which may be true, but a lot may be learned from them. Incidentally, the engineer may save himself money in useless patent fees and expenses.

The Design and Construction of a 12-Story Reinforced Concrete Building



FIG. 1—WORK ON THE LARKIN BUILDING, PHILADELPHIA, AUG. 16, 1913

This shows a general view of the form work, the square lattice columns, forms and reinforcement. In the foreground the centering is being finished up for the second floor; in the background the centering for the third floor is well under way

Modern construction practice is rapidly standardizing warehouse and factory structures, but emphasis could well be placed on the excellent design and construction features of the stairway and other details of the building described in the following notes. Every stairway is a fire escape, fire-proof, smokeproof, and panic proof. Attention to such details as these convert a fire-proof structure into a death-proof building.

A 12-story building of reinforced concrete is just being completed in Philadelphia for the Larkin Co., of Buffalo, N. Y. The first five floors will be occupied by the Larkin Co., while the seven top floors will, for the present at least, be rented for light manufacturing purposes, either in whole floors or smaller divisions. Designed for a floor load of 175 lbs. per sq. ft., the building is a particu-

larly sturdy structure, in which a number of difficulties, due to condition of the site, had to be overcome. The elevations were designed by Balingier & Perrot, architects, Philadelphia; the structural details were designed by J. C. Heckman, ch. engr. of the Larkin Co., Buffalo.; the building has been erected by the Abertaw Const. Co., Boston.

FOUNDATION AND BASEMENT PROBLEMS

Located on the block bounded by Arch and Cuthbert Sts., between 22nd and 23rd Sts., the site alongside the Schuylkill river is subject to ground seepage to a very considerable extent. The ground consists largely of river mud overlaid by 4' or 5' of promiscuous filling; it is not affected by the tide. Particular precautions had to be taken to keep the basement dry. It was found necessary, in order to avoid large accumulations of water and a heavy pumping equipment, to excavate separately to bed-rock for each of the column foundations (about 100 in number) before excavating the basement as a whole. The unusual amount of water around the piers in

the basement made it necessary to use integral waterproofing¹ in the concrete for footing and columns. A permanent sump-pit has been provided in the boiler room for use during extraordinary rises in the ground water and to keep down dangerously high water heads.

An existing two-story building occupying part of the block immediately adjacent to the new building caused complications in connection with the excavation on account of the pervious quality of the substratum of earth. It had to be protected by steel sheeting driven in to act as a retaining wall during the excavation for the large building.

The building measures 166' 3 1/4" long from Arch St. back to Cuthbert, and 136' 8 3/4" in the other direction. The height from the first floor to the roof is about 172'. The first story measures 16' 9" from floor surface to floor surface, the second and the third measuring 16' and 15' respectively, while all the others are 13' 6", except the 12th, which measures 13' 9 1/4" to the roof. All four sides

¹Waterproofing Co., N. Y. C.

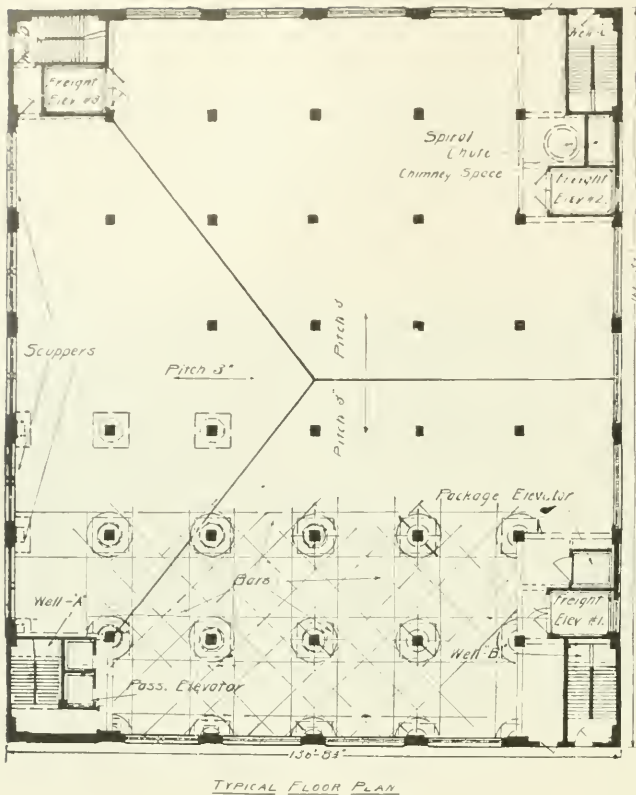


FIG. 2—GENERAL PLAN OF THE BUILDING SHOWING COLUMN ARRANGEMENT, STAIR WALLS, FIRE TOWERS AND FREIGHT ELEVATORS

A detail of the floor steel is shown in Fig. 9

of the structure are provided liberally with windows, the first floor having show windows for Larkin products, specialties and premiums. The window area is broken at the four corners of the building, principally to provide for fire escape stairways of the so-called "Philadelphia type" and for elevator shafts.

On these four corners the construction is solid reinforced concrete. Wooden forms were used on three of the walls and steel forms on the fourth in order to get a line on the relative economy. It figured out that the wooden forms, due to the larger panels which could be handled, showed a little better economy than the steel, but this advantage was neutralized by the fact that practically all of the steel forms were left in shape to be used over again on the next job. One advantage of the wooden forms over the steel was that the wooden forms could be raised in very large units by a pole derrick, thus placing wall forms at a very

low unit cost. This advantage held true, of course, only where forms could be placed in units.

The footings of columns, all of which were carried down to rock, consist of grillage measuring as much as 16' 3" x 16' 6" on the 23rd St. side, and 11' 4" x 11' 4" on the 22nd St. side. These were carried up into shafts varying from 4' 11" x 4' 11" to 6' 9" x 7' on the two sides, these latter dimensions being reached at the basement floor level. The deepest of these excavations is about 27' 6" below the first floor level, or 13' 7" below the bottom of the wall.

On the open side of the building the piers were made of double size to allow for a future extension without further excavation against the walls. This will permit of carrying the floor loads of the extension upon the existing piers.

THE CONSTRUCTION PLANT USED

In erecting this building advantage was taken by the contractors of the

fact that a part of the lot was vacant. Except for the cement, all of the material for concreting was delivered by teams either onto this vacant lot or to bins inside the lines of the building. Dredged gravel and crushed dredged pebbles were thus delivered into a boat with a bucket elevator,² carrying them up to a bin the top of which was on a level with the third story floor. The bins were located inside one corner of the building in a position later occupied by the stairway. Dredged sand was brought in in the same way as the rest of the aggregate.

The concrete tower was located in the freight elevator shaft in the same corner of the building as the aggregate bins. A mixer³ underneath these bins was supplied from a super-hopper, fitted with a measuring device between it and the bins. Cement came in on a side track on the adjoining lot, where at first it was stored in temporary sheds. After the building was up far enough, cement was stored on the first floor, well out of the weather. All of the hoists, as well as the mixer, were driven by electric power.

A steel tower was used for hoisting material. The standard mix of concrete was 1:2:4, which was varied for certain particular places, according to the needs of the moment. The aggregate, which was a dredged gravel, was well graded, all of it passing through a 1½-in. ring. The dredged sand was particularly coarse. There was no water check on the mixer foreman other than a swing barrel

²Link-Belt Co., Philadelphia

³Ransome Concrete Machy. Co., Dunellen, N. J.

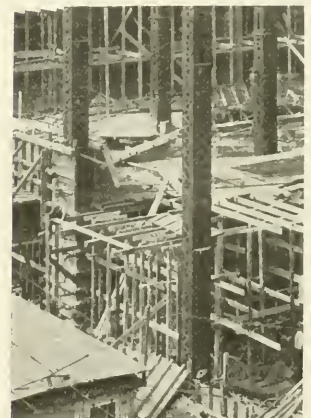


FIG. 3—THIS IS A DETAILED VIEW TAKEN FROM FIG. 1 AND SHOWS THE CENTERING AND STEEL MORE CLEARLY

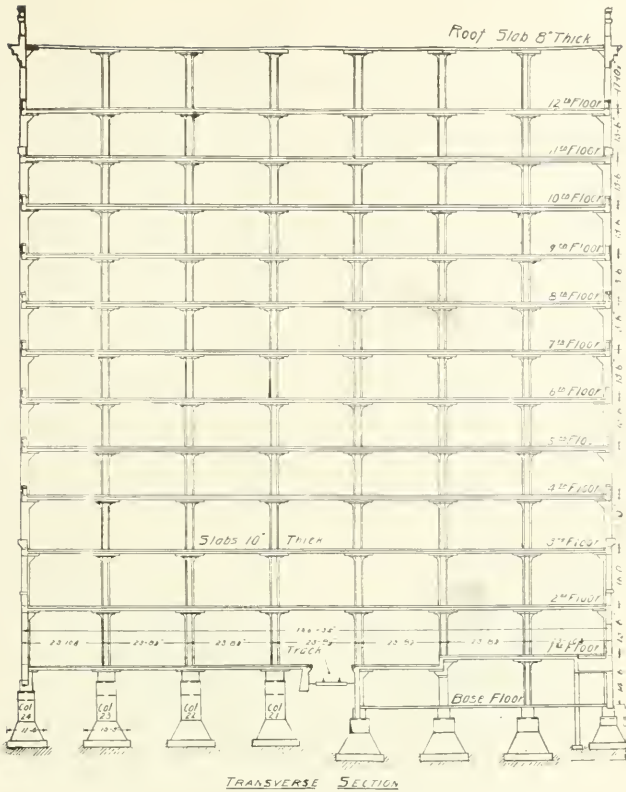


FIG. 4—GENERAL ELEVATION OF THE BUILDING, SHOWING THE FOOTINGS, BASEMENT ARRANGEMENT AND FLOOR HEIGHTS

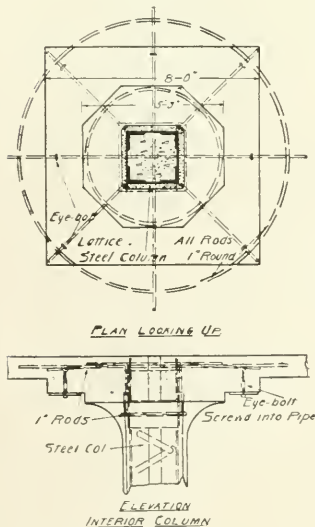


FIG. 5—DETAIL PLAN AND ELEVATION OF TYPICAL INTERIOR COLUMN

arrangement, the barrel being filled to a predetermined point for each batch.

The concrete was handled up above in industrial cars holding one batch each. Two cars were used nearly all the time, but for a part of the time, where a long run was required, three cars were in use. It was aimed to have the cars ready for the batch as it came up to the upper hopper, and in probably 49 cases out of 50, this was done. Only rarely was the hopper required to hold the material or to handle it in any way except as a chute.

STRUCTURAL COLUMNS AND STEEL REINFORCEMENT

Above the foundation shafts the columns proper consist of steel angles set at the corners of a 22-in. square and joined by steel lattice work as reinforcing for concrete columns varying from 28" x 28" up to 28" x 38". In most cases, particularly on the lowest floors, the steel reinforcement was amplified by addi-

tional angles and plates within the 22-in. square and attached rigidly to the corner angles. Above the first floor all the inside columns have a mushroom head, with the 22-in. "squares" continued up through them as the main reinforcement. Each column head has reinforcement consisting of an outer ring of a 1-in. steel rod 10' in diameter, with eight 1-in. radials tied to this ring by wire. The radials parallel with the sides of the 22-in. square, and running through the column, are 11' long; while the others, extending 4' out from the corners of that square, are turned down alongside the corners and rest upon angle irons about 3' below the floor surface. All this horizontal reinforcement for the column heads is

*Reinforcement furnished by the Corrugated Bar Co., Buffalo; rolled by the Lackawanna Steel Co.

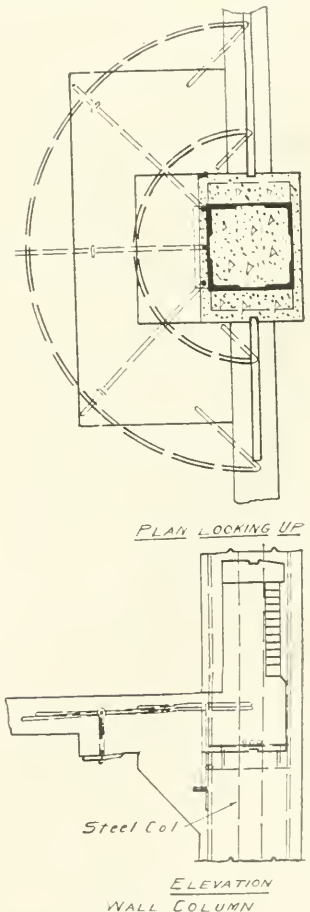


FIG. 6—PLAN AND ELEVATION OF TYPICAL WALL COLUMN

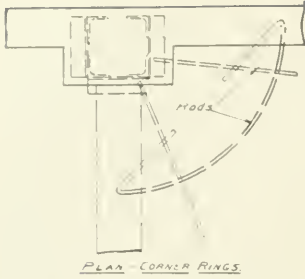


FIG. 7—PLAN SHOWING ARRANGEMENT OF REINFORCEMENT IN A CORNER COLUMN

3" or 4" below the floor surface in each case.

The lattice column reinforcement has made it possible to use one size of column from the first floor to the 11th, thus economizing in the cost of forms. Unusual care was exercised in supporting the steel work. Much of it was supported on eye-bolt standards from the forms until the concrete had an opportunity to set. Eight of these eye-bolts were used around each column head. Essentially, this eye-bolt is a small piece of pipe placed vertically through the floor, threaded on the inside. Into the upper end is screwed an eye-bolt, while the lower end is supported by a bolt screwed in and fastened to the forms. After the forms are removed, the bolt is unscrewed and the pipe filled with concrete.

The general column spacing throughout the building is 22' 9 $\frac{1}{2}$ " x 23' 8 $\frac{1}{2}$ " c. to c. The floor slabs, which are 10" thick, have an extensive reinforcement of $\frac{1}{2}$ -in. round steel bars arranged as shown in the accompanying detail. It will be seen that each panel is very rigidly reinforced with bars running both parallel with the four sides of the panel, and diagonal. There is special reinforcing around all air-ducts and other openings through the floors. At the walls there is additional reinforcing consisting of 12 $\frac{1}{2}$ -in. bars located 12" o. c. and about 6' long.

A REINFORCED FLOOR RESTING ON THE GROUND

The first floor, over the section which has no basement—that is, about half the area—is reinforced the same as the rest, because the poor character of the ground did not permit building this floor directly upon the earth without reinforcement, as is so frequently done. The only place where the floor slab varies from the 10-in. thickness is in one corner, from the fifth to the 12th floors above the package elevator. This elevator runs at present from

the first floor to the fourth floor only. A removable concrete floor slab 6" thick has been left above it for possible subsequent extension of its travel.

The removable slab, of which no detailed view is available, measured 8' x 8' 2 $\frac{1}{2}$ " x 6" thick. It was set in each floor in rabbets, giving it a 2-in. landing or support all the way around. In the bottom of the slab round steel reinforcing bars $\frac{3}{8}$ -in. in diameter were set 6" apart in both directions.

THE TOWER FIRE ESCAPES

The fire towers include in each case a fireproof stairway from top to bottom of the building within a structure completely separated from the rest of the building by fire walls. Both corners on 23rd St. have outside balconies. The only entrance to the fire tower is from this out-door balcony, which is reached by a door from the main portion of the building. In the other two cases the balconies are within the line of the

building—are open to the air in front—and are reached directly from the main portion of the building.

Pipe railings on both sides of each flight of stairs are installed without pipe fittings other than just sufficient to support the railing and hold it in place. All bends were made over a blacksmith's fire rather than by the use ofells or other devices. The dividing partition between sections of stairs in the fire towers consists of metal lathing covered with cement plaster, the whole partition being about 4" thick. The towers are lined with tile fireproofing supported on the floors.

ELEVATOR EQUIPMENT

There are three freight elevators at different corners of the building, back of the fire towers. The package elevator, already mentioned, is at the Arch and 23rd St. corner, while the two passenger elevators are on Arch St. on the 22nd St. side. A spiral chute for dropping packages from the packing room on the third

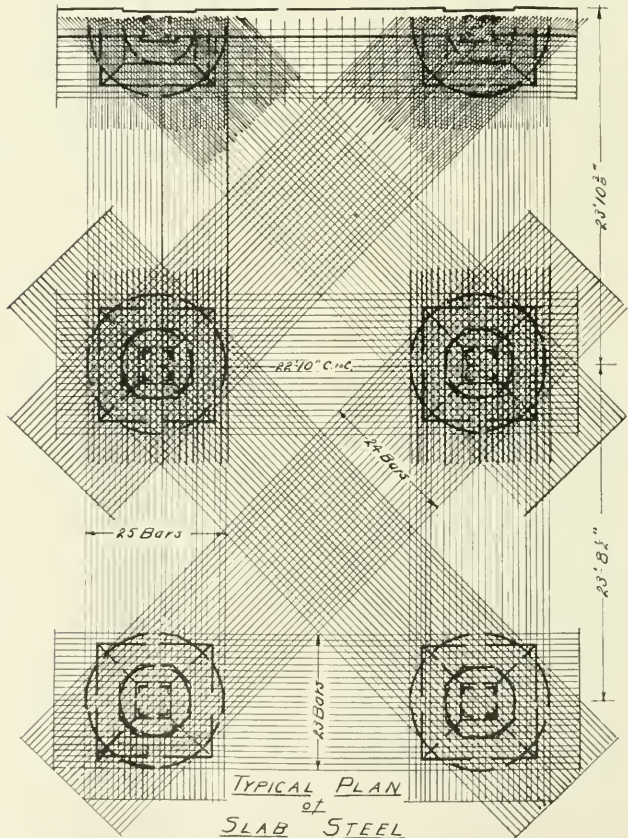
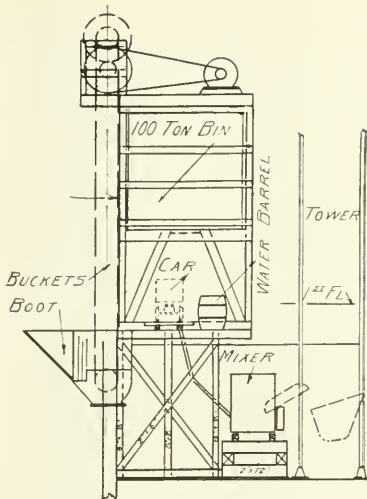


FIG. 8—DETAIL PLAN SHOWING TYPICAL ARRANGEMENT OF FLOOR STEEL



ELEVATION ON
LINE A-B.

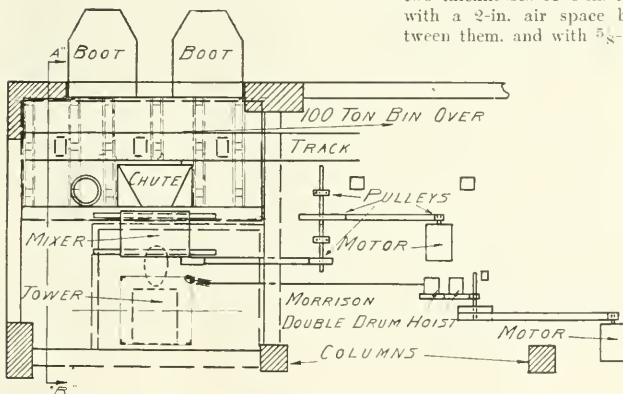


FIG. 9—PLAN AND SECTION SHOWING GENERAL LAYOUT OF THE CONCRETE PLANT USE

floor to the shipping department on the first floor is near the Cuthbert and 23rd St. corner. All the walls for all of these hoistways are of reinforced concrete.

GENERAL ARRANGEMENTS

The 1st floor, which, aside from the show windows around the outside, is mainly a freight terminal and shipping department, has a railroad track running almost entirely across it from the west or 23rd St. side. The top of the rails is 4' below the first floor level, and the opening through which the cars are run measures 16' wide x 17' 9 1/2" high. Advantage is taken of this track, which is led off from the Philadelphia and Reading R. R. main line, to locate the coal pocket in the basement right alongside it, so that the filling of this

pocket is made most convenient. Facilities are afforded also for teaming, in both the delivery and the shipping of goods. The doors for the railroad and the team entrances are of the horizontal folding type.⁵

About half the area of the second floor is a big show room. Most of the balance is occupied by the office, separated from the show room by a 7-ft. partition, the upper half of which is of glass. In the office proper, many special electrical connections have been provided, including a large number of telephone outlets, also outlets for dictographs, electric fans, etc. Bubble drinking fountains⁶ are located at intervals. The office vault, which measures 10' x 10' on the inside, has walls 11 1/4" thick, consisting of two thicknesses of 4-in. tile with a 2-in. air space between them, and with 5/8-in.

it is lined with fire brick 9" thick. Two fireproof rooms on the 23rd St. side of the basement excavation are shut off from the rest of the basement by 12-in. brick walls and automatic sliding fireproof doors. One of these is a transformer room, while the other is a pump room.

The chimney was built as an independent structure. It was not worked in with the floor steel at all. There was, however, a connection part way up, fitted with a hinged steel joint, to allow for expansion and contraction. Near the top of the chimney was a sliding contact for the purpose of permitting the chimney to expand vertically through this contact as a guide, with increasing temperatures, and correspondingly to contract when the temperature went down. In construction, the chimney followed the floors, but this was just a "happencence." Steel forms were used, both inside and outside, with excellent results. The cross-section of the chimney consisted of two half circles joined by straight lines practically elliptical.

POWER EQUIPMENT

Electric power, bought direct from the Philadelphia Electric Co., enters through the primary coils of the transformers in the basement. Such power as is needed by tenants on the upper floors, for manufacturing or for light, will be taken off the secondary coils and sold to those tenants by the Larkin Co. Elevators and all other power appliances within the building are run electrically.

GENERAL ARCHITECTURAL TREATMENT

The outside of the building, which is of particularly pleasing appearance, shows the concrete rubbed face for columns and wall beams, with curtain walls of a shale brick, picked colors, with deeply lagged horizontal joints, while the vertical joints are left flush. Except for the first two floors all the windows are of wired glass in rolled steel sash.⁷ Brick parapet walls are carried up above the roof on all four sides. The roof itself is divided into two parts, each of which pitches about 3 3/8" per ft. to individual drainage points about 15' from the Arch St. and the Cuthbert St. side of the building respectively. These drain pipes run down through the building adjacent to interior columns, on the opposite side of which are the two 6-in. risers for the automatic sprinkler system.

Except for ornamental metal doors,

cement plaster on the outside and the inside of the vault.

HEATING EQUIPMENT: A CONCRETE CHIMNEY

The basement, which is excavated on the Cuthbert St. side only, has a large boiler room in the southeast corner with three return tube tank boilers tested to about 100 lbs. per sq. in. These boilers are to be used for heating purposes only, the intention being not to run them above 6 lbs. They are alongside the coal pocket already mentioned.

The chimney is 195' high, built of reinforced concrete, using steel forms. For about 1/3 of the height

⁵Variety Mfg. Co., Chicago

⁶Springfield Sanitary Drinking Fountain Co., Chicopee, Mass.

⁷Blaw Steel Constr. Co., Pittsburgh

⁸"Fenestra" Steel Sash, Detroit Steel Products Co., Detroit

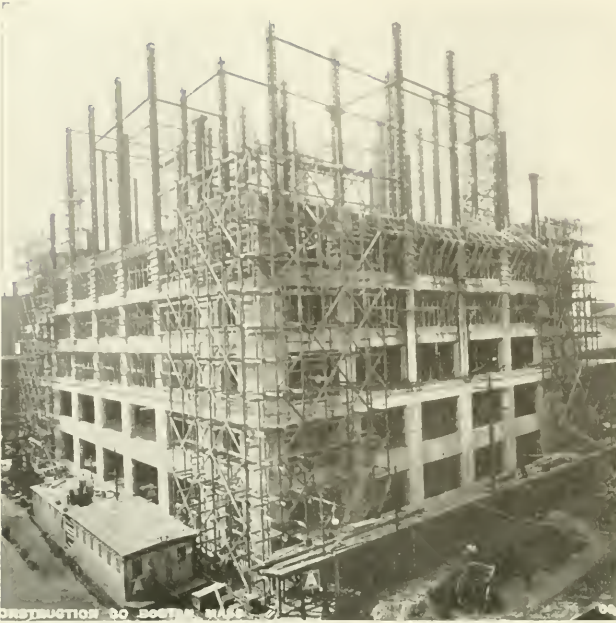


FIG. 10—THE LARKIN BUILDING SEPT. 27, 1913

This is substantially the same view as shown in Fig. 1 and indicates how the work has progressed. The fundamental features of the reinforced concrete frame are plainly indicated here. Note how the steel columns are carried up in advance of the concrete structure

all the doors are "Underwriters' label" fire doors. Those to the stairways, etc., were furnished by the company⁹ which also furnished the copper doors from the corner stairway adjacent to the passenger elevators, into the show room. This stairway, of Georgia marble, is a particularly handsome feature.

AUTOMATIC SPRINKLER INSTALLATION Aside from the structural features

⁹Kalamein Co., Long Island City, N. Y.

already mentioned in connection with the fireproof qualities of the building, a complete automatic sprinkler equipment (wet pipe system) has been fitted, drawing water from a 17-in. city main on the 22nd St. side, through a 6-in. connection into the basement. The sprinklers are located on lines which are in general 11' 5" apart, the heads themselves being spaced 7' 11". Both these dimensions vary according to local conditions in certain portions of the floors.

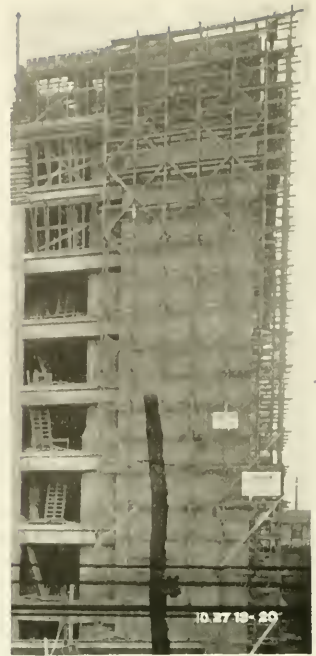


FIG. 12—A SECTION OF THE BUILDING FROM A VIEW TAKEN OCT. 27, 1913

This shows the interior of the building and the work on the reinforced concrete chimney progressing story by story with the building. The form work on the upper floors is shown

There are approximately 3,100 sprinkler heads in all, about 250 on each floor and 100 in the basement.

The fireproof pump room contains an "Underwriters" pump rated at 1,000 gals. per min., and driven by an electric motor. In addition to this there is the regular gravity tank service supplied by a 40,000-gal. roof

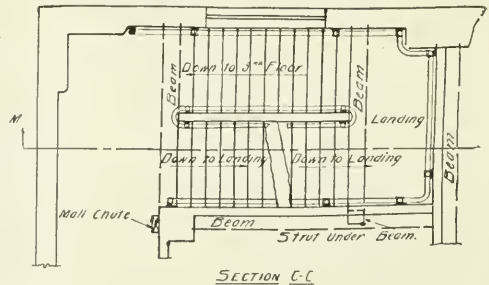
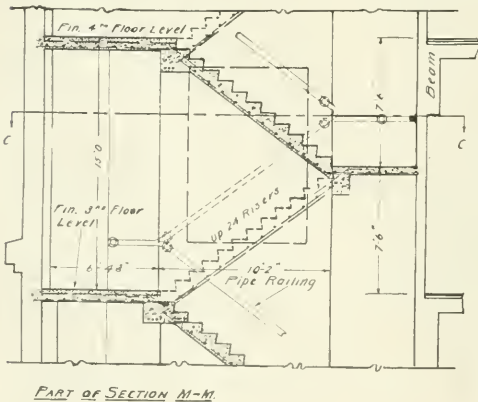


FIG. 11—DETAILS OF THE FIRE ESCAPE STAIRWAYS

These stairways are designed to be protected from any fire inside the building. They are immune from smoke and should be both fireproof and panic-proof

Stucco Work on Louisville Store Building

An interesting decorative effect in stucco was recently obtained by Mason Maury, archit., Louisville, on a store building at Third and Walnut streets, Louisville, which was re-modeled by him, by the use of a material obtained from some of the Georgia quarries, known as grinnette, and resembling marble chips, in combination with a heavy coat of stucco. See accompanying illustration. These chips, passing a $\frac{1}{4}$ -in. screen, were embedded in the stucco while the coat was still soft, the chips being carried in a very lean mixture, and the surface was then finished smoothly, and after the initial set, water was turned on, removing the surface cement.

The American Mosaic & Tile Co., Louisville, placed some colored mosaic tile designs.

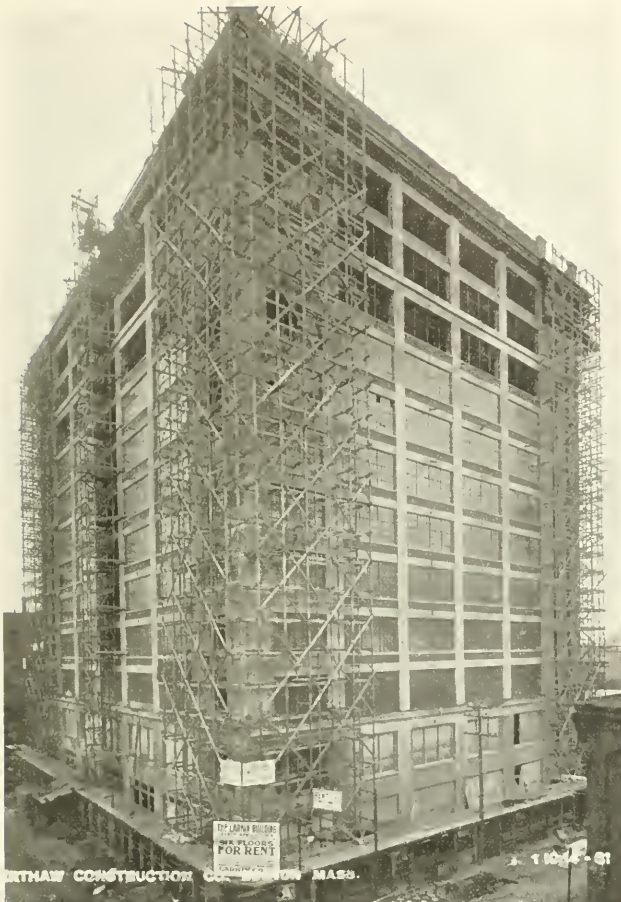


FIG. 13—THE LARKIN BUILDING JAN. 10, 1914

Seven of the twelve floors are completely glazed, while the steel sash is in place for two more floors

tank, the bottom of which is 25' above the highest sprinkler. As this places the bottom of the tank 200' above the sidewalk, and as the street service provides a pressure of only 40 lbs. per sq. in., pumps had to be fitted for filling not only this tank but the "house" tank for general water service located 170' above the ground. It will be seen that the water pressure in the sprinkler tanks in the basement and first floor is approximately 90 lbs. per sq. in. As a third source of water supply for the sprinklers there are two double steamer connections on the 22nd St. side.

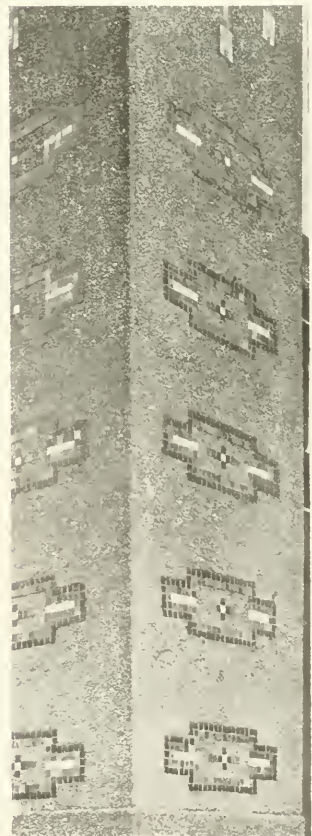
To avoid danger, adopt the safe course.

May, 1914

Bridge Construction in India

Writing in the current *Daily Consular and Trade Reports*, Consul Jose de Olivarez, Madras, India, states that the Mangari river, in the southern part of the Madras Presidency, is to be spanned by a new bridge where the road from Dindigul to Palnillo, in the Madura district, crosses the stream. For the construction of this bridge the government of Madras has appropriated \$3,989.

Steel and concrete are the principal materials used in bridge construction work in southern India, and as a considerable amount of such work is continually being carried on, American manufacturers and exporters of such commodities would do well to keep in touch with the Public Works Dept., Chepauk, Madras.



STUCCO WORK WITH WHITE AGGREGATE WASHED FREE OF CEMENT COVERING



FIG. 1—CONCRETE FIGURES SYMBOLIC OF THE SEASONS FORM THE MAIN SUPPORTS OF A RUSTIC PERGOLA; AND AT THE RIGHT AN END VIEW OF CONCRETE SEAT IN FRONT OF PERGOLA. THIS WORK IS ON THE CASTANA ESTATE OF ALBA B. JOHNSON, ROSEMONT, PA.

The Use of Concrete in Garden Ornamentation on Castana Estate, Rosemont, Pa.

All the ornamental concrete work shown in the illustrations is placed on different parts of the Castana estate, named for its magnificent chestnut trees. The estate is at Rosemont, Pa., near Philadelphia, and is the home of Alba B. Johnson, pres., of the Baldwin Locomotive Works.

The concrete stone work was done under the direction of Adolph Schilling.¹ The designs are by Alexander Mackie Adams, architect, the landscape designing by John S. Cope, both of Philadelphia. The co-operation of these men in this work has produced one of the finest examples of formal gardens in this country.

The concrete work is wet-cast and was made by the methods briefly described in the Jan., 1913, issue of CONCRETE-CEMENT AGE, in an article presented by Mr. Schilling before the Nat. Assn. of Cement Users, Pitts-

burgh, "Color and Texture of Concrete Products."

The particular aggregate in this work is a mixture of graded silica

sand and white marble with Medusa² Portland cement.

²Sandusky Portland Cement Co., Sandusky, O.



FIG. 2—ANOTHER VIEW OF PERGOLA SHOWING CONCRETE FLOWER URNS IN FOREGROUND
CONCRETE-CEMENT AGE

¹Mgr., Pompeian Stone Co., Haddon Heights, N. J.

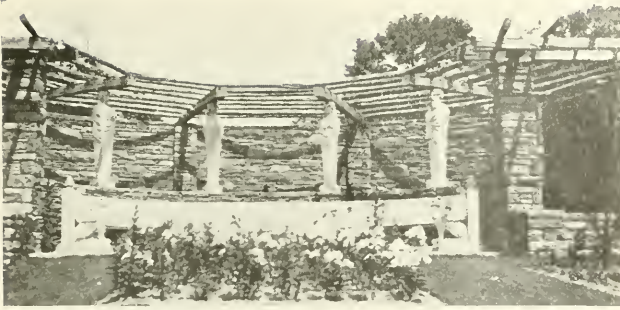


FIG. 3—GENERAL VIEW OF PERGOLA AND SEAT

The plain work was cast in plaster molds and the ornamental undercut work was cast in gelatin molds. After casting, at the age of 10 das., the pieces were immersed in large tanks, holding an acid solution, until the outer cement coating was removed. This treatment left a fine grain texture, similar to rubbed stone, and shows the aggregate to best advantage. The general color tone is a warm gray and ivory, it resembles in every respect the marble ornaments of the old gardens abroad.²

FEATURES OF CASTANA GARDENS

Nearest to the house is the Garden of Meditation, a rectangular piece of lawn formed by high hedges; its only decoration are the flower pots about 3' in diameter. These are arranged at each side of the lawn, and in the season filled with red geraniums, making a pleasing contrast with the green of the lawn and the old marble tone of the flower pots.

At the end of this garden is a statue of Eve Repentant, a piece of sculpture in marble, of the highest artistic merit, and the harmony of this with the cast stone shows the great possibilities of decoration in the use of well executed concrete products.

The upper garden is divided from the main lawn by a pergola of mas-



FIG. 4—GARDEN SEAT OF CONCRETE

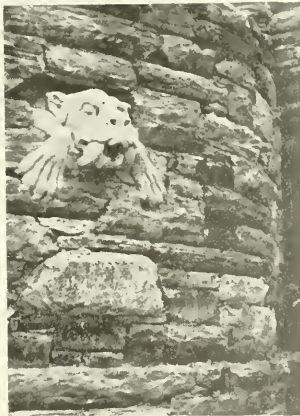


FIG. 5—ONE OF THE GROTESQUE SCULPTURES FOR ENTRANCE OF WATER TO SWIMMING POOL—THESE WERE CAST IN PLACE

THE WATER GARDEN

The lower or water garden is bordered at its highest level by a balustrade of unique design in keeping with the Gothic buttresses and wall effects. These are built of field stone and the balustrade is made of a concrete with rather a rough texture to harmonize with the stone piers.

At the foot of the balustrade is a swimming pool extending the full width of the garden and flanked by sets of steps. These are embellished with some especially well designed urns and vases. The water for this pool is supplied at each end, by grotesque spouts of water life. These were modeled in concrete direct on the stone walls, so as to produce the most natural effect—the heads apparently crawling out of the wall.

The central feature is a circular waterpool, about 18' in diameter, and



FIG. 6—GENERAL VIEW OF GARDENS, CASTANA ESTATE—ROSE TRELLIS, PERGOLA, SEATS AND POOL BASINS—SHOWING EXTENSIVE USE OF CONCRETE



FIG. 7—THESE VIEWS ON THE CISTANA ESTATE FEATURE THE ROSE TRELLIS AND SUMMER HOUSE—NOTE DETAIL IN COLUMNS OF ROSE TRELLIS

designed to overflow, forming a sheet of water around its entire top edge, this being caught in the gutter at the base of the coping, from there draining under ground and supplying the well at the lower end of the garden.

At the axis of this pool to the left is placed an exedra seat, 20' in diameter. This seat is flanked by specially well modeled griffins and the bench itself is enriched with a frieze of plant design interwoven with the names of the architects.

In the rear of this seat, at a higher level, is the pergola. The seasons, Spring, Summer, Autumn and Winter, are emblematically represented by the maiden, wife, mother and age. The outlookers and rafters of this pergola are cedar logs and rest directly on the statues.

Surrounding the center pool are

placed four circular benches supported on crouching water fauns. At the extreme end of the cultivated grounds has been placed a temple of Love, with the beautiful woodland as a background. It forms a splendid terminal of this formal garden. It is of Doric order in design and the well finished details show an excellent example of the best in stonecrete craft.

COLUMNS TURNED TO SHAPE

The columns here were molded or turned upon a skeleton of expanded metal in general as a stone column would be turned out of a rough block, by cutting off the surplus until only the final shape was left. In this case layer after layer of concrete was built up into a thoroughly welded mass, until the perfect column was created, true in line and texture and without a seam or casting mark.

Another interesting feature is the construction of the dome. After the parapet above the cornice was placed, the top ring or crown of the dome was set at its proper place, then eight ribs were fitted into grooves at the top of parapet and resting their upper end against the lower edge of the cross-piece. This formed a frame for the eight panels which closed the spaces between the ribs, the entire dome being formed of 17 pieces, no centering being used. The joints were then grouted and the outside of the dome received a coating of water-proofed concrete, finished to match the balance of the work, so that the inside of the temple shows a paneled ceiling, and the dome seems to be cast in one piece. The inside frieze is embellished by a border of dancing and singing youths, after Donatello. The floor of the temple is made of

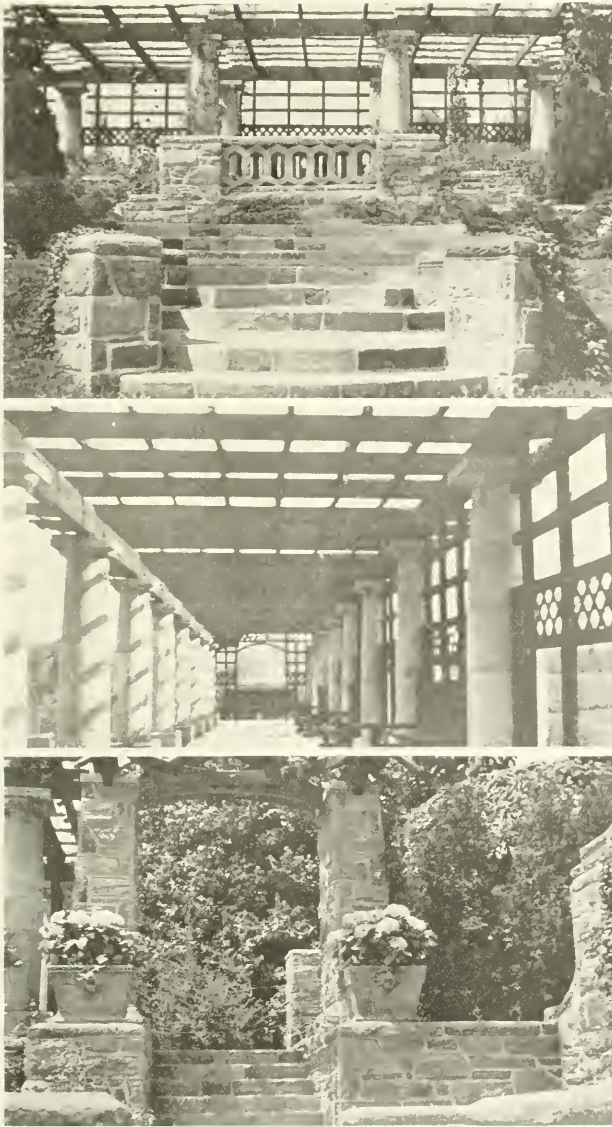


FIG. 8—TWO VIEWS OF PERGOLA WITH CONCRETE COLUMNS AND IN LOWER VIEW TWO CONCRETE FLOWER BOXES

concrete stone flagging in a geometric pattern.

Following is an account of some of Mr. Schilling's methods in concrete ornamental work, being an extract of his own paper published in this magazine in Jan., 1913:

To produce color effects, we may use the gray and white Portland cements, either by themselves, or mixed in certain proportion, adding to them suitable pigments. But, in many cases, the natural colored aggregates, sand, silica, pebble

grits, marble and granite, will give excellent and more uniform results.

The importance of mixing the pigment thoroughly with the cement, before adding the aggregates, should be appreciated by anybody attempting to make concrete in colors and there should be great care to avoid undue weakening of the cement.

As a very simple method to test the proper amalgamation of the pigment with the cement, take a handful of the mixture, and press it under a sheet of stiff paper. This will produce an even surface of the material, and as long as this surface does not show absolute uniformity in color, the mixing is incomplete.

The absorptive qualities of concrete during its stage of curing and seasoning, offer opportunities for coloring concrete products by capillary action. By this method, the color is deposited in the pores of the surface, amalgamating with the concrete in a permanent unit. The possibilities of this treatment are unlimited, but individual knowledge of coloring values and judgment, so as not to impair the strength requirements of concrete, are essential for success.

PENETRATION METHOD OF COLORING

Coloring solution can be made to penetrate the surface of concrete six inches or more, if the object is placed in the solution in a very green state. It is rarely necessary to penetrate more than $1/32$ in. to $1/8$ in.; this thoroughly fills all pores, gives the desired color effects, and is less expensive.

Every atom of coloring matter absorbed by the concrete reduces the strength of the solution; and as some of the coloring matter used is quite expensive, good judgment in allowing only the necessary absorption of coloring matter is advisable from an economic standpoint.

Aniline colors and the sulphates of copper and iron are the most suitable to make solutions in which to color concrete by the capillary method.

The concrete to be colored can be treated after it is several days old. Con-



FIG. 9—FLOWER URNS OF CONCRETE—ALL ON CASTANA ESTATE

gates, their natural color can be retained, while the absorptive parts will assume the desired color. In this treatment, precaution must be taken not to use certain acids in washing before immersion in the color bath, as the chemical action of the acids is likely to counteract the color value of the bath.

I find that concrete of proper age can be treated just like any natural stone, using the same tools and machinery to dress its surfaces and it is my strong conviction that the success of concrete stone for building purposes rests with a close affiliation of the stone-caster and the stone-cutter. In this way alone shall we be able to give concrete proper texture and the necessary qualities of dimension stone, so essential with the architect and builder.

For acid baths tanks of sufficient size should be constructed in a concrete shop, and the soaking of concrete surfaces in acid will not only result in a great saving of acid, but produce a class of work that cannot be obtained with the scrubbing brush.

This treatment preserves the edges and details of the design and makes the surface uniform.

Any of the hard spots not sufficiently affected by the acid bath can be treated



FIG. 10—CONCRETE BALUSTRADE WHERE A ROUGH TEXTURE AND A TONE TO HARMONIZE WITH NATURAL STONE WERE OBTAINED. THE SWIMMING POOL IS BELOW THE BALUSTRADE

crete products with strength requirement should not be subjected to the coloring bath until the concrete has attained its required strength, as the filling of the pores in the concrete stops the action of its curing by the usual methods.

Coloring by absorption is effective on surfaces of concrete after it comes out of the mold, or after being treated with acid or tools. Surfaces that have been colored by absorbing mineral or metallic colors become waterproof, and the action of the weather on the metallic colors is the same as on real metals, increasing the beauty of coloring by the usual oxidation noticed on bronze and copper. Surfaces of concrete treated by this method become so hard and dense that they will take a uniform dull or high gloss polish. I have treated such surfaces in the same manner as marble, granite and metal, under pol-

ishing or buffing machines.

Products made by these methods, such as flower pots, vases and boxes, will hold water after the second day of casting, and become so hard that when struck with a hammer they ring like a metal bell. I do not think waterproofing compounds are essential in obtaining this result, but consider the proper amount of water and thorough grading of the aggregates as all important.

I have obtained excellent two- and three-color effects by painting certain parts of objects before subjecting them to the coloring bath. The parts so colored would not be affected by the color in the bath.

The artistic possibilities of such treatment are limited only by the color sense and taste employed by the craftsman. By using certain non-absorptive aggre-

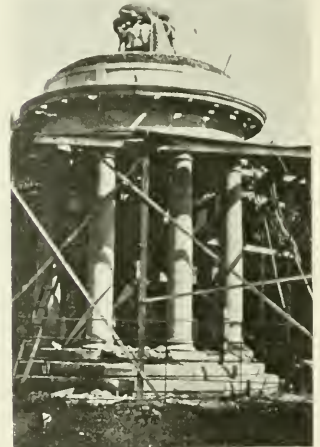


FIG. 11—THE TEMPLE OF LOVE UNDER CONSTRUCTION

separately after the article has been flushed with clear water. Care must be taken that aggregates of the surfaces are of nearly uniform hardness, or the acid will eat the soft portions out before the harder particles have been cleansed of the cement coating. I have had some very fine work spoiled, when, to obtain a certain fine effect, I mixed black marble (a limestone) with crushed granite. The acid bath left only the spaces where the black marble had been, while the granite showed a very fine texture and natural color.

Flower Boxes of Concrete Cast in Simple Wood Molds

The accompanying illustrations show concrete flower boxes used as a porch rail and to surmount corner posts at the home of P. E. McAllister, Barberton, O. Very simple wood molds sufficed for this work.

Concrete Houses for Government Employees in Canal Zone.

The U. S. government is building 20 4-apartment dwellings for the families of 80 American employes at Balboa and concrete is the principal material of construction.

From a recent *Canal Record* it is learned that work was begun Jan. 5; that excavation for the building foundations has been completed, and the work on the various buildings is now in all stages of advancement, between the pouring of concrete foundations and the erection of walls and floor arches as high as the second story. The work is being pushed to completion as rapidly as the materials can be obtained from the U. S.

The buildings will be provided with an open basement, extending the full length and width of the building, 90' x 35' 10". The clear head room in the basement will be about 6' 6", and the clear head room in the apartments will be 10'. The walls of the basement are of reinforced concrete. The remainder of the walls, including the interior partitions, are of hollow concrete block made by the Pauly system,¹ to be finished with stucco on the exterior, and cement plaster on the interior. The floor arches are of reinforced concrete, upon which will be laid redwood floor sleepers, with a filling of cinder concrete between; the floor of the apartments will be of comb-grained yellow pine nailed to the sleepers. The roof framing will

be of yellow pine, covered with roofing felt, and a top surface of red vitrified Spanish tile.

Each apartment of these houses, known as Type B, consists of five rooms and bath, with an 8-ft. 2-in. veranda the entire width of the apartment on the front, and an 11-ft. x 12-ft. veranda on the rear, called the "kitchen veranda." The apartment includes a living room, 11' x 14' 10", a dining room, 12' x 14', two bedrooms, each 11' x 12', a bathroom, 11' x 7', with a small hall to provide communication between the bedrooms, bathroom and the living room; and a kitchen 11' x 11'; also a dry room approximately 4' x 11', with a small closet in each bedroom. The bathroom is equipped with shower and tub, and the entire apartment is piped for hot and cold water. The floors on the verandas will be cement

finished. The roof of the building has a pitch of 1' and covers the verandas, projecting 4' 2" beyond. The door and window trim will be of cypress, and the hardware of brass, sand finished. The force now employed on this construction includes 40 gold (American) and 600 silver (native) employes.

MANUFACTURE OF CONCRETE BLOCK

The plant at Corozal for the manufacture of hollow concrete block, for use in the walls of buildings in the same manner as hollow terra cotta tile was established under the direction of A. A. Pauly,¹ and is turning out about 2,300 finished block in every shift of 8 hrs. Three gold and 60 silver men are employed on the day shift, and two gold and 52 silver men on the night shift. The block are being shipped to Balboa for the permanent administration building and permanent quarters, and to Gatun for the construction of the new transformer sub-station. In an average day's run of 8 hrs. the plant consumes about 270 bags of cement, 15 cu. yds. of sand, and 20 cu. yds. of screenings, the three components being mixed in the proportions, 3: 4½:6. The labor cost in the manufacture, under the present system, is less than the cost of materials; the total unit cost, including all the various items of administrative expense, labor, material and plant arbitrary, averages about \$.068 per block. Up to the morning of Feb. 22 approximately 295,365 block had been made.



FLOWER BOXES OF CONCRETE

In a recent article in this magazine attention was called to the diminishing conflagration figures of the U. S. and it was shown how in the face of the enormous additional construction, the fire loss had decreased. It was indicated that this was due possibly in a measure to the increased use of concrete construction. A proof of the truth of this suggestion is found in a recent report of a fire in Philadelphia. A large grocery firm occupying a concrete and steel structure was burned out. The contents of the building were necessarily of a very combustible character. The report of the fire states the fact that the building being "a concrete and steel structure was all that saved the adjoining buildings, including the Betsy Ross house, from complete destruction." This tribute to concrete construction is only one of many that are constantly being given, and it is to the fireproof qualities of this form of construction that in time to come the reduced fire loss in the U. S. will be largely due.

¹Youngstown, O.

The Production in Concrete of Statues for Boston's New City Hall Annex

By D. B. ADAMS¹



FIG. 1—CHARITY



FIG. 2—INDUSTRY



FIG. 3—EDUCATION



FIG. 4—LAW AND ORDER

Full-size clay models of statues cast of concrete for Boston City Hall Annex; Roger Noble Burnham, Sculptor; New England Cement Stone Co., Manufacturer

Many months ago the plans for the new Boston City Hall Annex, designed by E. T. P. Graham, showed four great concrete statues surmounting the concrete cornice of this building, adorning the front of a building constructed, with the exception mentioned, entirely of steel and limestone.

The sculptor who designed these statues is Roger Noble Burnham, Boston, and his work is receiving great praise and universally favorable criticism. He made his study sketches and then submitted 7-in. models, which were accepted by the Boston Art Commission. Working from these small plaster models Mr. Burnham made quarter-size plaster models which were complete in every

detail and furnished the dimensions with which the full-size figures were cast.

Each of these four statues is more than 16' high, semi-circular at the base and cut on a vertical plane up to the shoulders. That part from the shoulders down sets close to the limestone ashlar, while in each case the head pitches forward. To bring the statues to the attention of the casual observer was a difficult task as they were set over 100' above the Court St. sidewalk, and the street itself is a very narrow one. All four are female figures draped in the Græco-Roman style, and they symbolize Charity, Industry, Education, and Law and Order. The figure of Charity is a mother holding her child, which nestles close for the mother's protection. The mother holds her

free hand in a slightly extended position as if to ward off all possible harm. Industry carries the symbolic wheel in her right hand, and in her left the Græcian distaff. Education is a figure somewhat similar in its draperies to the preceding two and carries the quill and book. Law and Order carries the bundle of fasces symbolic of the power of punishment which the fasces bestowed on the Roman praetors, and in her left hand she holds the Book of Laws. All four possess great power of expression and dignity which cannot fail to impress the observer.

In Norwood, just under the shadow of Blue Hill, at the plant of the New England Cement Stone Co., preparations were made some three months before delivery was required for the construction of the clay mod-

¹New England Cement Stone Co., Boston



FIG. 5—QUARTER-SIZE MODEL BEING REPRODUCED FIRST IN SKELETON FRAME, BY MEANS OF PANTOGRAPH; FRAME TO BE OVERLAID WITH CLAY AND MODELED

FIG. 6—SHOWS RELATIVE SIZE OF SCULPTOR AND FINISHED CLAY MODEL

FIG. 7—AT THE EXTREME LEFT IS A PLASTER CAST; NEXT, A SKELETON FRAME; TWO QUARTER-SIZE MODELS AND A FULL SIZE CLAY MODEL

els. As each completed figure weighs approximately 8 tons, four small concrete floors, 8" thick, were put in 4' below the ordinary floor level in order to bring the statues down to a more convenient position to work on. Special arrangements were made for heating and lighting. Platforms for the quarter-size figures were placed so as to bring the models into a correct position relative to the arm of a pantograph to be used in reproducing them in full size.

MODELING IN CLAY

As soon as it arrived, the first model was placed on its platform, and the enlarging machine began locating corresponding points on the small and the large figures with a ratio of 1:4. As points on the large figure were approximately located, carpenters and modelers started the

actual work, building a skeleton framework of 2-in. x 4-in. stock, strapping and laths. An attempt was made to keep this framework within an inch or so of the finished surface, and this was done fairly well except in the draperies. As it was, the clay used in each one weighed between 2 tons and 3 tons. The preparatory work was slow and very expensive. Once finished, it was a comparatively easy job to throw on a rough covering of clay before handing the roughly outlined figure over to the sculptor. Mr. Burnham and his assistant then completed the clay figure, using their hands, and the modeling tool with a wire loop and a flat point, to bring out all the fine detail work.

Precautions were taken to keep the temperature of the shed as near 50° F. as possible and to keep the clay

moist. On very cold nights, because it was almost impossible to keep up a full head of steam, there was great danger of the clay ladies being frost-bitten. As a matter of fact, Jack Frost did perform several amputations on fingers and other exposed portions. The clay was kept moist by a wet cloth covering at night. As soon as a clay figure was completed the Boston Art Commission came to inspect it. The fact that there were only a few minor corrections speaks in itself for Mr. Burnham's skill. When whatever corrections there were had been made and the clay figure was finally approved by the Art Commission, the statue was ready for the next stage of its journey.

MAKING PLASTER MOLDS.

The plaster men started their work immediately, while the clay was still in good condition, and to prevent any possibility of the clay freezing. The best grade F. F. plaster was used in this work, being mixed quite wet in large dish-pans, and then applied directly to the clay. The men began at the bottom and worked up, making a reverse mold with a minimum thickness of 6". As the plaster was applied, strips of burlap were embedded in the plaster for reinforcement. It was first planned to make each statue in four pieces, but at the request of those in charge of the work it was decided to build the body in one piece, and the head separately. As each body was about 13' high, a supporting cradle was necessary, one that would take all of the stress incurred in moving the mold to its horizontal position for casting. The cradle was built of 2-in. x 4-in. and 4-in. x 4-in. spruce, strongly braced to resist torsion and thoroughly attached to the plaster mold by several ties extending from the framework into the plaster shell itself.

The mold dried in two days and then the clay and framework, which had performed their task, were ready to be removed. In this case, as the figures were built against a back wall, a small portion of this outside wall was torn out and the frame and clay were passed out from the inside, leaving the plaster mold undisturbed. The head was taken off at a specially prepared joint running from shoulder to shoulder where the draperies would help hide any traces of it. The projecting feet were also removed at the bottom of the draperies.

The cradle, built to enable the mold to be safely moved, has been mentioned. It had been the intention in the first place to allow the plaster mold to remain in an upright position, build the core in sections, and



FIG. 8—A QUARTER-SIZE MODEL AND A FULL-SIZE MODEL IN CLAY



FIG. 9—COVERING CLAY MODEL WITH PLASTER—ABOUT HALF COMPLETED



FIG. 10—LOWERING PLASTER CAST IN CRADLE TO HORIZONTAL POSITION

pour the concrete from the top, but considerations of placing and supporting the reinforcing, the extra labor of pouring because of the height and lack of room, and some difficulty which was anticipated in getting the huge blocks out of their concrete well, decided the question in favor of laying the first plaster mold in a horizontal position. This was so satisfactory that the three others were handled in the same way. These plaster molds were extremely heavy and cumbersome, and the grave danger of breaking when they were being tipped over added to the difficulty. No matter how strongly they were braced there was always a certain amount of give to the wooden

supports and plaster, of course, is extremely brittle. Only one of them did break and this one sprung a vertical crack which caused several days' work. Jacks were utilized to push the sides together, the crack was carefully plastered and the cradle practically rebuilt. In each case the feet of the figure projected 1' or so, and had they been left attached they would have been completely smashed when the mold tipped forward.

PLACING STEEL AND CONCRETE

When the mold had been placed in its horizontal position the inside was given two coats of orange shellac; meanwhile, the steel men worked on the $\frac{3}{8}$ -in. and $\frac{3}{4}$ -in. reinforcing.

This work of placing steel was not all fun, by any means; $\frac{3}{8}$ -in. rods, bent to conform to the draperies of the figure, were placed at 8-ft. intervals, while through each vertical fold a $\frac{3}{4}$ -in. bar was laid. At the back of the shoulders a heavy horizontal bar was put in, with its ends slipped into the looped ends of vertical rods on each side. This made a convenient form, seven of the horizontal reinforcing rods were carried across the back to aid in resisting any force which might cause a vertical crack. This was important, as each concrete figure was turned completely over so as to bring the front side uppermost, and a break would have caused a very serious loss.

After the steel was laid, a wooden core was suspended from bars on the top of the mold and the core was firmly braced. Cores were carefully made so as to conform as nearly as possible to the shape of the mold, and at the same time allow a minimum thickness of 6". There were, of course, many projecting parts where the concrete was more than 1' 6" thick.

Much experimenting had been done in an effort to obtain a stone which would in every particular match the Indiana limestone ashlar. The cement, the sand, the amount of lime used and the coloring substances all had various characteristic effects. It was difficult to obtain a stone of fine enough texture and of the correct color. The various combinations of mineral colors and cement gave very different results. Even after a satis-



FIG. 11—PLACING THE REINFORCING IN THE PLASTER CAST



FIG. 12—PLACING AND TAMPING THE CONCRETE

factory combination was found, the color, particularly the red, gave a great deal of trouble, from the fact that different shipments of this color varied slightly in shade. The final mixture of sand, marble, lime, cement and color gave a thoroughly satisfactory stone, a stone which satisfied the Boston Art Commission, and at a short distance could not be distinguished from the natural stone. The mixture had only one disadvantage—it was very slow-setting.

The casting of each figure took about 15 hrs. of continuous work. The mix was dumped into the mold as fast as two tampers could thoroughly work it into all the holes and crevices. The rough casting surface of the mold made this job a very slow one, as it was desired to produce a finished cast without any air-holes on the surface. The two tampers could work from inside the core and the mix was well placed. As soon as the mix began to stiffen the slightest bit, as much as possible of a coarse 1:7 mix was put in for backing. This was placed next to the core, as soon as it was certain that none of the coarser material would sink through to the face.

After casting, the whole thing was left alone for two weeks. At the end of this time the mold with its concrete load was turned right side up onto skids which ran out of the building, and laborers went to work with axes chopping off the plaster. This was a simple enough job, only requiring a little attention and care. When the concrete was stripped it was of a dark olive color, this effect being produced by the wet cement on the surface and the water still present. For another week the figure was sprayed twice a day, allowing

the water to stand in the hollows whenever it would. In this way the danger of surface cracks, as far as they result from green concrete stone, was obviated. At the end of this period, three men went to work with hand stone-cutting tools and two automatic tools. These men worked under the direction of the sculptor, carving out effects in the concrete, as they would have done in limestone, for this special concrete stone cut like limestone in every way. This tooling removed all the neat cement surface and made the stone safe against any cracking and subsequent discoloration on the surface. The final effect was that of high-grade cut limestone, and the finished product was in every way entirely satisfactory to so critical a body of experts as the Boston Art Commission.

Being on skids it was a simple matter to haul the huge 8-ton piece of stone onto a truck and to deliver it under a derrick at the Boston City Hall. Once there, a very few minutes sufficed to unload a figure and to swing it 100' or more up to its lofty perch.

There are two points of importance to be noticed in this job: First,

that concrete stone should always have the surface, which was next to the mold when cast, removed by crandalling, bushing, chiseling or rubbing; Second, that concrete stone can be made, not successfully to imitate limestone or any other stone, but so as to produce a stone which is thoroughly satisfactory in appearance,



FIG. 13—A FINISHED CONCRETE HEAD

and eminently worthy of being accepted by the building public on its own merits and not as an imitation. For when the day comes when "concrete stone" is specified instead of "artificial limestone," "imitation limestone," and so on, as is so often done, then, and then only, will "concrete stone" come into its own.

While busy making yourself safe, take a little time to make your fellow-workman safe, too.

Don't get hurt first and then try safety. Try "Safety First" and you won't get hurt.



FIG. 14—A FINISHED BODY READY FOR DELIVERY

The Use of Belt Conveyors in Heavy Concrete Dam Construction

By J. A. BRIED¹

before work is resumed next season.

When finally completed, the dam, which is of the arch type, will measure:

Length	1,000'
Thickness of bottom.....	186'
Height (at present it is about 225' high).....	305'

MATERIAL HANDLING EQUIPMENT

Interesting to engineers and contractors is the method of handling the great quantity (over three train loads of 20 cars each per day) of concrete material before and after mixing.

The mixer house is located on the mountain side above the dam site and the material is alternately chuted down by gravity and then elevated on rapidly moving belt conveyors until it arrives at the forms to be filled. Using a belt conveyor for the rapid transportation of wet concrete is quite a new departure and especially so is the elevation of such material on belt conveyors, owing to the tendency of the water to separate out and run back. However, by speeding up the belt to some 100' per min. this tendency is negligible and the success of the installation can be appreciated through the fact that over 2,000 cu. yds. of wet concrete were thus conveyed to the forms in a working day of 10 hrs.—a record-breaking pour in any similar undertaking, it is claimed.

When construction was first undertaken about a year ago, the company operated its own quarries, crushers and screening plant to obtain the concrete material and also had a complete sand and gravel washing plant erected to secure the finer constituents for the concrete from a large deposit near the dam site. But for the last eight months the company has been obtaining from the vicinity of Colfax a good quality of river gravel and sand of just the right proportions suitable for concrete and, owing to the short haul (about 15 mi.) and plentiful supply, the quarry and crushing operations have been entirely discontinued.

The gravel as obtained from the river bed is carried in steel cars over the company's own spur tracks—from the Southern Pacific Ry.'s main line—to the dam site and dumped into bins directly over the three different size belt conveyors formerly used to carry the rock, sand and cement separately but now all used for gravel.

The belt conveyors are fed with gravel from the openings in the bottoms of the bins by means of automatic reciprocating feeders, and after being conveyed to the mixer house are discharged by trippers,



FIG. 1—GENERAL VIEW OF THE 1,000-FT. CONCRETE DAM, LAKE SPAULDING, CAL.

This view shows the general arrangement of the concrete plant (in the upper right hand corner) and the belt conveyor and chutes for the concrete

Belt conveyors and chutes are being used to advantage in placing a great mass of concrete in a California dam. A belt conveyor is in a way a chute, a moving trough, as it were, and on the work briefly described in the following notes the equipment used presents many features of interest.

In the construction of the Pacific Gas & Electric Co.'s concrete dam at Lake Spaulding, Cal., several features present unusual interest, not alone to engineers, but to concrete contractors and builders generally.

The dam is to impound the waters of Lake Spaulding and is part of a hydro-electric power generating system to increase the capacity of the Pacific Gas & Electric Co.'s already extensive electrical resources; it is being thrown across a mountain

gorge in the high Sierras near Emigrant Gap, Cal., some 170 miles from San Francisco.

The elevation of the lake is about 1,800 ft. above sea level and the total height of the dam is to be about 300 ft., so as ultimately to increase the depth or raise the surface of the lake to this extent, which will, of course, cause it to spread over a considerably larger area than at present—it is estimated 805 acres—with a catchment area of some 120 sq. mi.

Water from the lake will be conveyed through two pressure intake tunnels (8' 8" in diameter, concrete lined), canals and enormous pipes to the forebay and electric generating station on the Bear River, Nevada Co., 10.8 mi. distant. In fact, the system has already been placed in partial operation, as the first water was passed through Thanksgiving Day, 1913, and though the dam is still a year from completion, it is nevertheless high enough to hold what water is expected to accumulate

¹Meese & Gottfried Co., San Francisco

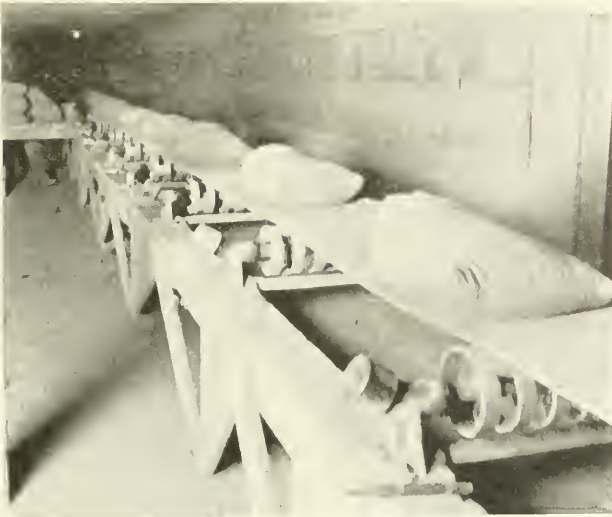


FIG. 2—A BELT CONVEYOR HANDLING 6,000 TO 8,000 SACKS OF CEMENT PER DAY, LAKE SPAULDING DAM

into bins above the concrete mixers. The sacks of cement (6,000 to 8,000 per da.) are also carried from cars on belt conveyors to the mixing house, where five 1-yd. mixers of the revolving drum type are kept in constant operation, which discharge the mixed concrete directly onto a hori-

zontal belt conveyor traveling at a speed of some 400 ft. per min. This conveyor discharges into a gravity chute leading down the hillside to the first elevating belt conveyor, which carries it upward at an angle of 18° to a tower erected on the dam, from which it is chuted down



FIG. 3—WET CONCRETE BEING HANDLED ON A BELT CONVEYOR TRAVELING AT 400 FT. PER MIN. UP AN INCLINE OF 15°

This is a reproduction of a snapshot. Another conveyor can be seen at the left

to another belt conveyor, operating at an angle of about 15° and again carried upward to the final gravity chute.

The general view of the dam (Fig. 1) shows clearly the gravity chutes

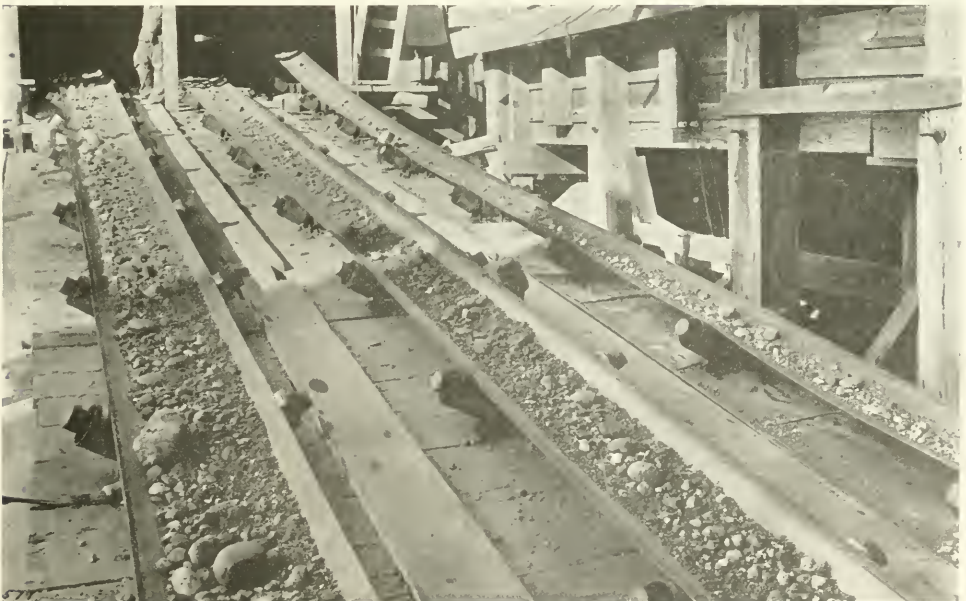


FIG. 4—BELT CONVEYORS CARRYING GRAVEL AS DUG FROM THE RIVER BED

The three belts were formerly used for crushed rock, sand and cement before gravel was adopted May, 1914

from the mixing house leading down to the belt conveyors and chutes erected over the dam.

A complete description of the tunnels, pipe lines and power house would make interesting reading but space forbids; suffice to say that the power house, known as Drum Power Station, which is to be operated by the water of the lake, is one of the most modern in the country, being entirely of steel and concrete construction 77' wide x 208' long. It is equipped with two double overhung impulse water wheels, operating electric generators of 35,500 h. p. capacity, though the capacity will be doubled when the dam is finally completed.

At present the current is transmitted at 100,000 volts to the Cordelia sub-station over 100 mi. to the westward, at which point it is stepped down to 60,000 volts and transmitted to the various bay cities.

The total cost of the project will run over \$10,000,000; the cost of the dam alone when completed will be about \$2,000,000. All of the belt conveyors, elevating and concrete material handling equipment used in constructing the dam was manufactured in San Francisco by the Meese & Gottfried Co.

As an engineering feat the project is one of the noteworthy achievements of the times and reflects great credit on the engineers of the Pa-

cific Gas & Electric Co., responsible for its success. Chief among these are F. G. Baum, R. G. Clifford, D. H. Duncanson, L. E. Spangler, P. E. Magerstadt, A. E. Chodzko and a host of other workers, division superintendents, etc. As many as 1,500 men at a time were employed on the big undertaking.

Concrete House Design in England—Prizes Offered

With evidences of the wonderful growth of concrete construction, it seems a far cry back to the competition for concrete houses which the Assn. of Am. Portland Cement Mfrs. carried through nearly 10 yrs. ago. The seed, however, then planted has borne fruit in many ways, not only in broadening the field of concrete construction of houses, cottages and other forms of domestic construction, but by leading to the institution of many similar competitions in this country as well as abroad. The Pittsburgh competition is still within the minds of all of us and now we have another similar test inaugurated by *Concrete and Constructional Engineering*, of London, with prizes to be awarded for the best designs for a suitable detached or semi-detached laborer's cottage, largely or mainly of concrete.

The conditions of the competition, which were published in *Concrete and Constructional Engineering*, London, relate to houses of the description above given, which are to be erected in sets of six in the Home Counties of England (at least 30 miles from Charing Cross) at a prime cost to the owners of £125 (\$625) per cottage. The first prize is 100 guineas (\$500), the second prize 50 guineas (\$250), the third prize 25 guineas (\$125), and the fourth and the fifth prize 10 guineas (\$50) each. The competition closes May 15, 1914, and the judges are Max Clarke, F. R. I. B. A., Prof. Beresford Pite, F. R. I. B. A., and Edwin O. Sachs, F. R. S. Ed.

The purpose of the competition is in the right direction, as housing the laboring man is a burning question in England and has almost grown into an important political issue. If by reason of competitions of this kind it is found that comfortable and economical concrete houses can be erected much good will be done directly to the laboring man, who will be afforded home comforts at a minimum rent. Indirectly, to the cement manufacturers and the constructors in concrete great benefits will also follow.

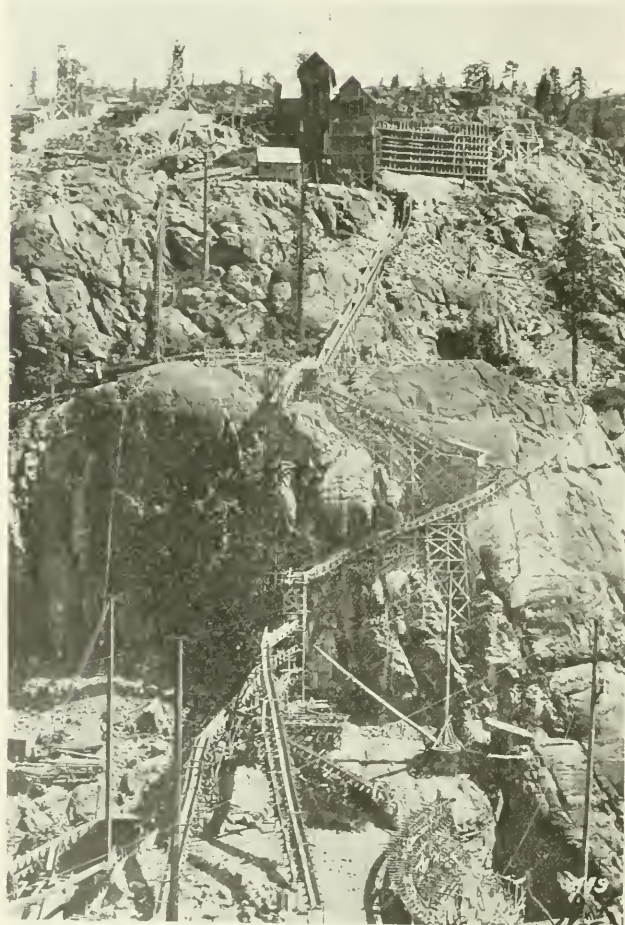


FIG. 5—THE PLANT AT THE LAKE SPAULDING DAM

This view was taken July 7, 1913, two weeks before this outfit made what is claimed to be the world's record of placing 40,185 cu. yds. of concrete in a month, which it did in Aug., 1913. The material bins and mixers are shown in the background. The long chute, baffle towers, etc., are in the foreground.

Concrete Road Construction by the Ohio State Highway Department

By H. D. BRUNING²

The operation of the State Highway Dept. of Ohio is confined to the construction, improvement and maintenance of certain roads, designated as inter-county highways, which form a system connecting the principal centers of commerce within the state. Being thus the main arteries of travel, they demand an improvement which will bear the burden of traffic of medium and heavy density. No detailed traffic census has been undertaken by the department, and the decision as to the kind of pavement to be used is not wholly dependent on the character and amount of traffic, but in a great measure on the character of materials most available. Where traffic conditions are the deciding factors, local authorities are consulted as to present traffic, and an estimate made as to the probable growth due to improvements and increasing commercial activities. Owing to the wide availability of materials suitable for first-class concrete construction in the state, the concrete road has found its place among the several types of roads used by the department. The total mileage of concrete roads completed to date is 39.63 miles, and the mileage under construction and let, 25.06 miles, making a total of 64.69 miles. The first concrete road constructed by the department was completed in July, 1911, and the total mileage of concrete roads constructed, under construction and let, represents about 16% of the mileage of all classes of roads put under contract since that time. It is thus apparent that the concrete road has a great prominence in the road-building art in Ohio, and the demand for such roads is growing day by day. Such demands often come from farmers and other users of horse-drawn vehicles; this fact seems to eliminate the oft-quoted objection that this type of road, when untreated with a bituminous mat, is hard on country-bred horses.

The materials for aggregate of concrete are distributed over the entire state, and nearly every mile of road in the state is within reach of

these materials at a reasonable haulage distance. The western half of the state is an area in which limestone is abundant, and the eastern part is supplied to a great extent with furnace slag dumps. Again, the northern and the western section of the state are covered with a mantle of clay, sand and gravel, resting directly on the hard bed-rock. This mantle was brought in and deposited by the great sheet of ice which at one time covered much of North America. The melting of this sheet of ice formed waters, which assorted the glacial materials, and deposited them in beds of clay, sand and gravel. Thus vast beds of gravel remain in the valleys of the Ohio, Muskingum, Hocking, Miami and Scioto Rivers. Some 150 quarries, operating in the limestone belt, and 30 sand and gravel washing and screening plants are shipping their products into the markets of the state. In addition to these local sand and gravel deposits and limestone quarries are found in sections with no railroad facilities. Thus it may be said that no section of the state can be found in which concrete materials of prescribed character are not available within a reasonable hauling distance.

The term concrete roads, as used heretofore, and used hereafter in this paper, means cement-concrete roads. Three types of concrete pavements have been constructed by the department, namely: Single-course plain, two-course plain, and single course reinforced. The standard type is the single-course plain concrete pavement laid on the natural foundation, except in the case of road No. 1, (see accompanying table), where on about one-half of the road a 4-in. slab was laid on a waterbound slag foundation, which is giving entire satisfaction after 18 months' use.

TWO-COURSE CONSTRUCTION.

A two-course pavement (road No. 9) 12' wide, was constructed in Lake County in the season of 1913. The aggregate in the base course is unscrubbed second quality gravel, and in the wearing course are crushed boulders and bank sand, all found locally. The cost of this improvement would have been excessive had the material been shipped in, on ac-

count of the long haul of 7 miles from the nearest railroad delivery point. The wearing course was laid before the base course had begun to set, never more than 15 min. elapsing between the placing of the two courses. A very satisfactory bond was obtained and to date no separation between the courses nor cracks are visible in the concrete.

REINFORCED CONCRETE.

Two single-course reinforced pavements (roads No. 5 and 20) were constructed in Harrison and Pike counties in 1911, being the first concrete roads constructed by the department. In both cases the work is located on roads that are subject to overflow, and it was partly on this account that concrete was selected. The concrete, made in the weak proportion of 1 part cement, 2½ parts sand, and 5 parts gravel, was reinforced with No. 11 wire, woven to a 6-in. mesh. The reinforcing was placed midway between the upper and the lower surface. Transverse joints were placed every 50' at an angle of 45° with the line of the road. The surface of the concrete was rough floated with a plank template, giving a safe footing for horses. Careful inspection of both roads after about 2½ years' service shows that no cracks are apparent in the road in Pike county, and only four sections of the 1.25 miles in Harrison county were cracked transversely, and the size of the cracks is inappreciable. The joints on both roads show considerable wear, due largely to the oblique direction. In general the concrete, although lean in the proportion of cement, shows very little wear.

The importance of a well-prepared sub-grade in concrete road construction has been recognized in all the work done. The specifications have been closely followed in the matter of uniformly compacting the road-bed with a self-propelled roller, weighing not less than 6 tons; all depressions which develop during the rolling are filled with acceptable material, and re-rolled until the entire road-bed is uniform in cross-section and thoroughly compacted. No special provision for drainage of the sub-grade has been found necessary, as in all cases the sub-soil has not been retentive, and ample drainage is secured through the side ditches. To date no set standard cross-section for the pavement has been adopted. Three types of cross-sections have been used: 1—A uniform thickness of concrete over the entire width of the pavement, forming the same amount of crown in the surface of the sub-grade as

¹Presented at the National Conference on Concrete Road Building, Chicago, Feb., 1914

²Division Engr., Ohio State Highway Dept.

TABULAR DESCRIPTION OF OHIO CONCRETE ROAD CONSTRUCTION

NUMBER	COUNTY	NAME OF ROAD	ROAD COMPLETED	CONTRACT PRICE	LENGTH FEET	WIDTH OF PAVEMENT IN FEET	DEPTH SIDE (INCHES)	SQ. YARDS	COST PER CU. YD.	SUBSOIL	PLAIN OR SURFACE TREATED	CEMENT	MATERIALS	REMARKS
1	Ashtabula	Anderson	Oct. 1912	1,228,500	8,523.161	16	6"	151.52	7630	0.811	Surface Treated	Universal	Lake Sand	Gravel, Concrete, Washed River Gravel
2	Ashtabula	Geneva	Aug. 1913	914,600	528.0	16	6"	93.86	9146	1.038	-	Universal	Lake Sand	Silica Regrains, Washed River Gravel
3	Erie	Lake Shore	Sept. 1913	709,900	530.0	12	6"	70.67	7099	1.004	-	Madison	Lake Sand	Crushed Limestone
4	Franklin	Sec. 25 Winchester	Nov. 1913	2,100,000	11,320.14	14	6"	176.09	9813	1.192	-	Universal	Unscreened River Gravel	1-14-33
5	Harrison	Piedmont	Nov. 1912	1,043,700	66.0	12.5	6"	100.70	8346	1.036	Plain	Lehigh	Bank Sand	Screened Gravel
6	Harrison	Sec. 10	Nov. 1913	232,890.00	13,600.254	10	7"	151.11	9163	1.541	Surface Treated	Universal	Washed River Sand	Crushed Limestone, Washed River Gravel
7	Holmes	Sec. 25 Millersburg & Berlin	Oct. 1913	515,000	17,950.34	16	6"	31.92	16912	1.800	-	Universal	Bank Sand	Crushed Limestone
8	Lake	Madison Southern	June 1913	119,700.00	746.5	12	6"	99.53	8489	1.202	-	Lehigh	Lake Sand	Crushed Limestone
9	Lake	Weeds Corner Extension	Aug. 1913	250,100.00	11,686.221	12	4"	15.58	11317	1.605	-	Crescent	Lake Sand, Crushed Limestone, Unscreened 2nd Quality Gravel	1-14-33
10	Lucas	Monroe Turnpike	Dec. 1913	319,250.00	10,807.205	16	6"	191.89	15573	1.664	-	Universal & Wapakonate	Canada Sand	Crushed Slag
11	Madison	Youngstown & New Bedford	Aug. 1913	156,450.00	6,600.125	14	6"	102.43	12516	1.527	-	New Castle	Washed River Sand	Washed River Gravel
12	Meeker	Reservoir	Jan. 1912	128,809.92	843.6	16	6"	131.54	8000	0.980	Plain	Remular	Washed Sand	Washed Gravel
13	Miami	Sec. 11 Aquia-Troy	Dec. 1912	1,623,700	980.0	18.6	6"	174.22	8729	0.932	Surface Treated	Universal	Washed Sand	Washed Unscreened Gravel
14	Miami	Sec. 23 Aquia-Troy	Dec. 1913	36,000.00	219.09	15	6"	38.95	8616	0.974	Plain	Superior	Washed Bank Sand	Washed Unscreened Bank Gravel
15	Mustkingum	Dresden Turnway	Nov. 1912	744,000.00	5,550.107	16	6"	99.67	7149	0.754	Surface Treated	Universal	Unscreened Bank Sand	Washed Bank Gravel
16	Pickaway	Circleville & Washington	May 1913	119,611.8	512.4	20	7"	113.87	12331	1.050	-	Ignition & Alpha	Washed Bank Sand	Washed Gravel
17	Pickaway	Circleville & London	Sept. 1913	110,141.3	528.0	16	6"	95.87	11014	1.173	-	Alpha	Washed Bank Sand	Crushed Boulders
18	Pickaway	Cincinnati & Zanesville	Dec. 1913	139,750.00	5,600.106	16	7"	99.56	13183	1.403	Plain	Alpha	Washed Bank Sand	Washed Gravel
19	Pike	Columbus & Portsmouth	July 1911	92,474	174.0	12	6"	170.7	3851	0.541	-	Superior	Unscreened Bank Gravel	1-14-33
20	Pike	Columbus & Portsmouth Extension	Oct. 1912	1,467,066	9,200.17	12	6"	122.7	8629	1.195	Surface Treated	Universal	Unscreened Bank Gravel	1-14-33
21	Purmon	Kalido-Lima	Nov. 1913	526,100	2,175.0	20	6"	45.23	12931	1.163	Plain	Diamond	Canada Sand	Crushed Limestone
22	Purmon	Pomer	Aug. 1913	14,860.00	102.0	14	6"	15.87	7430	0.936	-	-	Canada Sand	Crushed Limestone
23	Ross	Frankfort	Nov. 1912	1,092,500	696.9	13.1	16	5"	123.89	8339	Surface Treated	Superior	Unscreened River Gravel	1-14-33
24	Ross	Chillicothe & Jackson	Jan. 1913	115,186.62	528.0	16	5"	101.31	11518	1.136	-	Alpha	Washed Bank Sand	Crushed Boulders
25	Ross	Columbus	Nov. 1913	967,158	528.0	16	6"	95.86	9671	1.020	-	Superior	Unscreened River Gravel	1-14-33
26	Summit	Ghent	Nov. 1913	178,890.00	2,546.238	14	6"	195.16	7516	0.916	-	Universal	Creek Sand	Crushed Slag
27	Trumbull	Marion Northern	Nov. 1913	184,000.00	1,470.0	12	6"	189.33	6840	0.972	-	Universal	Silica Sand	Crushed Slag
28	Washington	New Martinsburg	Dec. 1912	12,125,000	528.0	16	6"	93.87	12125	1.292	-	Alpha	Washed River Sand	Washed River Gravel
29	Franklin	Columbus & Lancaster	Sept. 1913	733,715	375.0	14	6"	58.33	10371	1.758	-	Alpha	Unscreened River Gravel	1-14-33

Average Cost, exclusive
of engineering but
including grading

Per Mile \$96.06
Per Square yard \$1.128

Miles 39.63
TOTALS Squares Yards 337,301
Contract Prices \$38,666.37

TABULAR DESCRIPTION OF OHIO CONCRETE ROAD CONSTRUCTION—Continued

REPORTED FROM EXAMINATION MADE JANUARY, 1914

NUMBER	SURFACE TREATMENT	JOINTS	END OF TRAFFIC	MAXIMUM CRACK PERCENT	METHOD OF CURING	LONGITUDINAL CRACKS	DEFECTS		CONDITION OF JOINTS	CONDITION OF SURFACE	REMARKS
							Transverse Cracks	No. Per Foot			
1	Tarva & Silica Balmel	Poured Tar	30	Heavy	4.5	Sand & Water	Several	1	1 1/4 ft. Slightly worn	10 mo. Period	4" Concrete on slag macadam. Foundation
2	Tarva & Silica Balmel	Flasite	30	Medium	1.7	Daily Watering	7	1	3. Worn	2. Blocks peeled slightly, remainder good	
3	Carbor & Balmel	Poured Tar	30	Medium	4.9	Daily Watering	0	0	O.K.	4.0 ft. peeled in patches	
4	Tarva & Balmel	Flasite	30	Medium	2.9	Daily Watering	0	0	Good		
5	Tarva & Balmel	Poured Tar	55	Light	8.5	Straw & Water	0	7	6 ft. 4" 1/2 ft. Several badly worn		
6	Tarva & River Sand	Flasite	30	Very light	8.0	Clay & Water	0	1	3" 1/4 ft.	Top peeled, dirty surface	Very Surface
7	Tarva & Bank Sand	Poured Tar	30	Medium	7.0	Sand & Water	0	0	O.K.	Bottom Surface	
8	Tarva & Silica Balmel	Poured Tar	30	Heavy	5.2	Clay & Water	0	0	Unseen	8 ft. small patches peeled, remainder good	
9	Tarva & Screenings from Balmels	Flasite	30	Medium	4.0	Daily Watering	0	1	3 1/2 ft. 7 ft. 4 ft. 7 badly worn	3 ft. 4 ft. peeled, remainder good	2 Course Concrete
10	Carbor & Sand	Tar Paper	30	Medium	3.6	Daily Watering	0	0	0	No peeling, quite gritty worn	Artificial Drainage
11	Phyva & Sand	Poured Tar & Flasite	30	Heavy	4.9	Daily Watering	2	0	0		
12		Tar Paper	30	Medium	0.19	Daily Watering	65	0	1 1/2 ft. 7 ft. 4 ft. Slightly worn		Road located on Pleasant bore
13	Pyrite & Sand	Boat Poles	30, 40 ft.	Heavy	0.90	Daily Watering	121	48		Practically all peeled	Concrete worn considerably, 3"
14		Boat Poles	30, 40 ft.	Heavy	1.05	Daily Watering	32	132		One 30 ft. section has 4 transverse cracks	
15	Tarva & Coarse Sand	Poured Tar	30, 15 ft.	Medium	7.24	Sand & Water	7	30	6 ft. 1 1/2 ft. 20 ft. 4 ft. Several worn	8 ft. 4 ft. peeled, remainder badly worn	Concrete disintegrating in several places
16	Gravel & Sand	Poured Bitum.	30	Very loose	7.0	Daily Watering	0	0	0	5.0 ft. peeled	Has successfully withstood a 10 foot cover of water with strong current
17	Pyrite & Balmel	Flasite	30	Medium	0.45	Straw & Water	0	0	0	Very good	
18		Flasite	30	Heavy	0.22	Daily Watering	0	1	0	11 joints, quite slipped over	Transverse crack on 60 foot section
19		Poured Tar	50	Medium	7.5	Straw & Water	0	1	10 ft. 1 1/2 ft. 20 ft. 6 ft. badly worn		Concrete re enforced
20	Tarva & Fine Gravel	Poured Tar	30	Medium	0.53	Straw & Water	0	1	0	Very good	
21		Tar Paper	30	Heavy	0.98	Water & Sandblast	0	0	0		
22		Tar Paper	30	Heavy	1.5	Daily Watering	0	0	0		
23	Tarva & Unscreened Silica	Poured Tar	30	Heavy	1.5	Straw & Water	17	1	11 ft. 1 1/2 ft. 20 ft. 4 ft. Several badly worn	7.0 ft. 4 ft. peeled	
24	Tarva & Balmel	Poured Tar	30	Medium	6.0	Straw & Water	0	0	1	3" 1/2 ft. 4 ft. 10 ft. 4 ft. 10 ft.	5.0 ft. peeled
25	Pyrite & Balmel	Flasite	30	Medium	0.85	Daily Watering	0	0	0	Very good	Shows signs of peeling
26	Tarva & Sand	Poured Tar	30	Heavy	5.0	Daily Watering	0	0	1	3" 1/2 ft. O.K.	200 Sq ft. peeled
27	Pyrite & Silica Balmel	Poured Tar	30	Medium	5.0	Daily Watering	0	0	0	O.K.	4 ft. 4 ft. peeled in patches
28	Tarva & Coarse Sand	Poured Tar	30	Medium	0.85	Sand & Water	0	0	0		
29	Tarva & Balmel	Flasite	30	Medium	1.15	Sand & Water	0	0	0	7 ft. 4 ft. peeled	

in the concrete surface: 2—A thickness of concrete greater at the center than at the sides, leaving some crown in the sub-grade: 3—A greater thickness of concrete at the center than at the sides, built upon a flat sub-grade.

No greatly differing results in the types are found in the permanency of the pavements constructed, and it would be difficult to select the type which would exceed the other two in qualification to withstand the effects of heavy loads and extreme temperatures. A reference to the table will show the various thicknesses used.

The standard crown is $1\frac{1}{4}"$ to $1"$. This has been found sufficient to insure perfect drainage of a concrete road with the usual small imperfections in the surface, and after the road becomes coated with a mat of dirt. The ability to drain itself at once with so small a crown becomes one of the merits of the concrete pavement.

GOOD MATERIALS

Defects in the roads constructed do not point to any faults in the details of the design of the cross-section, as they do to the details of inspection. To assist in the matter of inspection, a well equipped laboratory is maintained by the department, and all materials entering into the construction are given thorough standard tests. A very important requirement in first-class concrete construction is to get a sand of good quality, and where sand of a doubtful character is submitted, it is tested for tensile strength, the requirements of the specifications being that the tensile strength of briquettes made with the proposed sand shall not be less than the tensile strength of briquettes with standard Ottawa sand and the same cement. Cement is tested in car load lots.

PROPORTIONS

The proportions now used in all concrete road construction by the department are 1 part cement, $1\frac{1}{2}$ parts of fine aggregate and 3 parts of coarse aggregate. The proportions of the mortar are maintained uniformly 1 part cement to $1\frac{1}{2}$ parts of fine aggregate, and the amount of coarse aggregate is varied somewhat for the different classes of material, so that there is an excess of about 10% of mortar over the voids in the coarse aggregate as an advantage in finishing. Although the leaner mix used on the first two roads, namely, 1 part cement, $2\frac{1}{2}$ parts of fine aggregate and 5 parts coarse aggregate has given fairly good results, it was found necessary to employ the richer mix to assure absolutely satisfactory

results. A lean mix requires much more care in mixing and placing, and it is in these items that causes of defects and failures in concrete roads are prominent. At least, this has been the experience of the department.

MIXING

The mixing is done by machine mixers of the type known as batch mixers. No continuous mixers are allowed to be used. Before any work of mixing and placing concrete is started, the engineer in charge determines the proper proportion of the coarse aggregate to secure maximum density and the excess mortar of 10% above the amount required to fill the voids in the coarse aggregate. The materials are measured by methods which will insure uniform proportions at all times. Usually this is done in wheelbarrows, which are gauged accurately as to capacity; but in a few instances the measuring has been done in cubical boxes containing 1 cu. ft. Our greatest trouble in the past has been to maintain a uniform consistency of the concrete, but this trouble has been greatly alleviated since the contractors' forces are becoming more experienced in this class of work. The concrete is made sufficiently wet to require no tamping, but there is a strong tendency among the contractors to make it sloppy, which necessarily results in some separation of the coarse aggregate from the mortar. This tendency has resulted in the formation of waves on some of the heavy grades due to the creeping of the concrete. On the heaviest grade it is advisable to use a somewhat drier mixture, and this rule has been carried out in our construction wherever possible.

After the surface of the concrete has been shaped by the use of a template, it is floated with a wooden float in such a manner as thoroughly to compact and seal the surface, and produce a surface conforming to the exact crown. No depression is allowed in the finished work which is greater than $1\frac{1}{2}"$, from a 10-ft. straight edge applied to the surface of the concrete and parallel to the center line of the pavement.

The specifications provide that within 1 hr. after the surface of the concrete has been floated, a canvas covering shall be placed over it and left in place for at least 12 hrs. This provision has not been carried out in all cases, but instead the surface has been kept wet by sprinkling. The sprinkling is continued for at least 5 das. and in most cases a covering of sand, dirt or straw has been used to assist in retaining the moisture. This

precaution is absolutely essential to secure the very best wearing qualities of the concrete.

JOINTS

A common point of failure in pavements thus far constructed is in the expansion-contraction joints, which on most of the roads have been placed at intervals of 30', but in some cases, for reasons unknown to the writer, a greater spacing was made. However, this failure is usually in cases in which poured joints were used, and the writer's observation is that this source of failure has been largely eliminated by the use of tared felt joints. In our road (No. 14) Baker plates have been used and the results are fairly satisfactory, although some wear is apparent, due probably to the imperfect placing of the plates. A reference to the table will at once show that transverse cracks do not appear, except in rare cases, where joints are not more than 30' apart, but in all cases these cracks occur in large number where the joints have a spacing greater than 30'. On Road No. 14, Sec. 3 of the Piqua-Troy Road, one 90-ft. section developed 4 transverse cracks, 6 sections, 3 such cracks; and 21 sections, 2 cracks. In no case do these cracks show any appreciable wear, but they will doubtless prove to be a source of annoyance in maintenance of the road after several years' service.

In this connection, it may be of interest to state that a 12-ft. pavement, 6,946' long, was completed as a monolith in Sept., 1912, by the county of Huron. The aggregates were Bellevue crushed limestone and Canadian sand. Six sacks of cement were used per cu. yd. of concrete. Over one-half of the road the thickness is 6", and the pavement rests on clay sub-soil. Over the other half the average thickness is 5", and the minimum of 4" laid on old sandstone foundation. On inspection made last month, (Jan., 1914), it was found that 85 transverse cracks had formed, ranging in spacing from 9' to 159'. The cracks are very irregular and several are badly worn. The same general condition both as to number and spacing of the cracks existed on each half of the road.

BITUMINOUS SURFACES

The much discussed question of the advisability of treating the surface of concrete pavements with a bituminous mat is being investigated very carefully by the department. The results thus far obtained on 25 roads so treated have rather discouraged

²R. D. Baker Co., Detroit.

further general application. The method of surfacing the concrete with the bitumen is as follows:

After the concrete has well hardened, a period of not less than 10 das. being specified, shall elapse after the concrete has been placed, tar or asphalt heated to from 200° to 250° F. is applied, in quantity equal to $\frac{1}{2}$ gal. per sq. yd., and spread uniformly over the surface. While the tar is still soft there is applied a layer of coarse sand or pea gravel in amount of one cu. yd. to about 100 sq. yds. of surface. This forms a mat varying in thickness from $\frac{1}{8}$ " to $\frac{1}{4}$ ". Present specifications limit the covering to tar products and gravel, ranging in size from $\frac{1}{8}$ " to $\frac{1}{4}$ ".

On inspection just made by the writer and Division Engineer Harwood Lersch, the data obtained show that on only four out of 23 roads treated has the bitumen given good results; on all other roads it has peeled off in varying degrees as shown in the table. An examination of the tar mat that peels off almost universally shows that the tar has adhering to its under surface a film of inert mortar, from 1-32" to $\frac{1}{8}$ " in thickness, that has been separated from the surface of the concrete. It thus seems that the peeling is not due to failure of the adhesion of the tar to the concrete, but the peeling is due either to an action of some ingredient in the tar on the concrete surface, or more likely to the nature of the concrete itself, which makes it possible for the tar to pick up the top film of the concrete. Where the treatment is an oil asphalt this condition is not true, and it is the experience of the department that such a product can not be successfully made to adhere to the concrete.

The life of a bituminous tar treatment (where the material adheres to the surface) depends upon many factors. To determine accurately these factors is something of a problem. Examination of the various roads reveals that a tar mat filled with sand wears off much more rapidly than one filled with pea gravel, which will resist abrasion to a higher degree. The treatment of tar and sand on road No. 11 (Youngstown-New Bedford) indicates a probable life of not to exceed two years, the covering having worn down to a thin mat not exceeding 1-16" after a use of only 7 mos. under heavy mixed traffic. At a cost of 9.5 cts. per sq. yd. for such treatment, which is an average cost on all roads treated, the maintenance cost would be rather excessive.

An interesting fact has revealed itself on Section 19 of the South High St. experimental road at Columbus,

constructed under force account by the maintenance bureau of the department. A Dolarway⁴ treatment was applied at the rate of 0.36 gals. per sq. yd., and covered with coarse sand. The 33' at the south end of this section was given two applications of the tar and sand. The part given one application peeled badly, while the part given two applications holds, and is in good condition after 15 mos.⁵ use under very heavy mixed traffic. The latter presents very much the appearance of an asphalt pavement. On Section 20 of this same road where Tarvia⁵ was used, what peeling has taken place has been on the parts which received the least tar.

REPAIR OF CRACKS

Owing to the apparent short life of the bituminous wearing course as heretofore applied, it would appear in the light of present knowledge of the subject to be uneconomical to apply such surfacing, or attempt to maintain a bituminous top on the pavements thus far treated in this manner. However, the use of tar for treating cracks which develop in the pavement and the use of tar and mineral aggregate for patching defects such as worn joints and holes are very effective and apparently the cheapest method of maintaining a good surface on such a road. Such repairs should be made at least once every year. The cracks, joints, or depressions should be swept clean of all foreign matter before the heated tar is applied. The mineral aggregate should be clean, thoroughly dry, and of a size practically as large as the depth of the hole. If fine material is used the traffic will drive the tar to the top. This tar concrete should be thoroughly tamped. While asphalt may be used for filling joints and cracks, it is usually advisable to repair depressions in the surface at the same time, and for this latter purpose, tar has given the best results.

There are, of course, exceptions and situations that can be cited where possibly some advantage can be gained by the use of the bituminous surface treatment over the entire pavement, as for example in the case of badly cracked and checked pavements. To date, no systematic operation of maintenance has been developed by the department, but a complete organization for maintenance, under the immediate charge of superintendents employed by the department, is being perfected.

The average cost of the concrete pavements completed to date is \$1.128 per sq. yd., as set forth in the table. This cost is the contract price paid and does not include the cost and expense of engineering and inspection, but does include the cost of grading and finishing of shoulders and ditches and a small amount of accessories. Deducting from this average cost the average cost of surface treatment, which is 9 $\frac{1}{2}$ cts. per sq. yd., there remains \$1.033 as the average cost per sq. yd. of plain concrete including grading, shoulders and accessories. The average cost of grading, finishing of shoulders and ditches and accessories is 0.167 per sq. yd. of paved surface. Deducting this from \$1.033 we have 86.6 cts. as the average cost per sq. yd. of the plain pavement alone exclusive of engineering and inspection costs.

Examinations of the details of the 29 roads completed, during and after construction, give information from which we are able to draw the following conclusions:

1. That careful and intelligent inspection and the use of first class material only, are essential to the construction of concrete pavements to insure permanency.

2. That the use of bank-run gravel or crusher-run limestone should not be permitted.

3. That a rich mixture is necessary as a factor of safety against irregularities in mixing and placing concrete.

4. That the wearing quality of the pavement is often greatly impaired by insufficient protection against too rapid drying.

5. That there is no apparent difference in the permanency of pavements constructed on either a flat sub-grade or on a sub-grade having a crown.

6. That the weakest points in the pavement are at the expansion-contraction joints and that tarred felt is preferable to a poured joint.

7. That the part of the shoulders next to the concrete pavement should be reinforced by placing stone or gravel macadam on 1' to 2' of the shoulders next to the pavement. This will avoid the usual formation of a rut in the shoulder which tends to retain the surface water.

8. That a bituminous surface treatment is not essential to a good concrete pavement.

9. That observations indicate that there is no special value in roughening the surface of the concrete preparatory to putting on the surface treatment, and such roughening will tend to increase the wear if the sur-

⁴Dolarway Paving Co., N. Y. C.

⁵Barrett Mfg. Co., N. Y. C.

face coat is worn away and not replaced.

10. That asphalts used as a surface treatment for concrete have peeled more than tars.

11. That the results secured in the surface treatment of the present time do not warrant its use to a great extent, but experiments should be carried forward in sufficient number to learn further facts and establish, or disprove, those already thought to be known.

12. That first class concrete pavements have every indication of ability to stand up under heavy steel tire traffic.

Milwaukee Has a Bureau of Quantity Surveying

A recent issue of the *Quantity Surveyor* states that Milwaukee, Wis., contractors are displaying much activity and interest in the matter of better estimating methods. Some of the most progressive men in the business are now arranging for the establishment of a Bur. of Quantity Surveying, where bills of quantities prepared by experienced men may be obtained by bidders in all trades when work is upon the market. This is actual progress, and will lead to the early adoption of even more progressive methods later on, when the quantities estimated upon will form the basis of the contract.

The Extension Division of the Univ. of Wisconsin, Madison, Wis., offers a course in reinforced concrete for men in practice, enabling them to secure at low cost a comprehensive knowledge of the theory and practice of present-day building design. The course is open to all who have had a fair training or experience in the elementary principles of structures and who have a fair understanding of algebra, geometry, trigonometry, mechanical drawing and strength of materials.

Preparatory studies are offered, enabling those to qualify for the course who have not had the necessary training in mathematics or in the elements of structures. Enrollments will be received any time, as the work of the Univ. Extension Division continued without interruption throughout the year.

Investigate every accident that happens in your gang, and try to prevent a second accident from occurring in a like manner.

Further Reports from the First National Conference on Concrete Road Building

In the Mar., 1914, issue brief references were made in the report of the Proceedings of the National Conference on Road Building to the report of Committee No. 10 on the Economical Handling and Hauling of Materials; Committee No. 11 on Mixing and Placing of Materials; and Committee No. 13 on Thickness, Crown and Grades. These reports are now printed practically in full.

The committee on the Economical Handling and Hauling of Materials was composed of H. P. Gillette, editor *Engineering and Contracting*, chairman; Donald G. Price, State Engineer, Lincoln, Neb.; Percy H. Wilson, secy., Assn. of Am. Portland Cement Mfrs., Philadelphia. The report presented by the chairman is as follows:

The materials to be handled in the construction of a concrete road are:

(1) Water, (2) Cement, (3) Sand, and (4) Gravel or Stone.

Water—The first mentioned material, water, is quite apt to be given scant consideration by the road builder whose experience has been limited to work within cities or villages. Likewise the engineer or contractor who has never before attempted road construction is prone to underestimate the cost of securing and delivering water, whether for concrete or macadam roads in country districts. In arid regions a mistake of this sort may readily result in serious financial loss.

The chairman of your committee has been financially interested in the building of concrete roads under conditions that have served to emphasize the importance of considering the cost of water and of ways and means to reduce that cost.

Water, it should be remembered, is used for at least three purposes in building concrete roads: (1) To wet the sub-grade; (2) to mix the concrete; and (3) to keep the concrete moist for several days after it is laid. On a sandy sub-grade that must be wet and rolled before laying the concrete, as much as 100 gals. of water per cu. yd. of concrete may be used, merely to wet the sub-grade. Then an additional 50 gals. or more per cu. yd. will be required to mix the concrete wet enough to flow readily. Finally as much as 80 gals. per cu. yd. of concrete will be needed to keep the concrete wet for a week after it is laid, if the air is very dry and if there is much wind. A total of 230 gals. of water, weighing 1,900 lbs., has been required for each cu. yd. of concrete, in one case known to your chairman. More than that would have been used had the concrete not been kept covered with a layer of earth an inch or more thick. The earth, of course, retarded evaporation of the water. The water in this case was hauled in tank wagons, so there was no guessing as to the total amount used, although its distribution among its three different uses was not accurately determined.

A ton of water per cu. yd. of concrete may probably be regarded as the maximum that need ever be required. A quarter of a ton of water per cu. yd. is probably the minimum, if there is to be any sprinkling of the sub-grade and of the concrete. A two-mile haul at 25 cts. per ton-mile results in a cost of 50 cts. per cu. yd. of concrete for hauling the water where the maximum amount is needed. This is astonishing indeed to the contractor who has been accustomed to mix and place concrete for 50 cts. per cu. yd. under certain conditions.

When large quantities of water are to be moved considerable distances pipe lines should usually be laid along the road and the water should be pumped. Quite a common mistake, when this is done, is to use pipe of such small diameter that the friction head makes it impossible to deliver the quantity of water needed. Thus a 1-in. pipe is often laid where a 2-in. pipe is needed. Any engineer, however, is competent to estimate the size of pipe required under given conditions. It should be remembered that the head against which the pump is acting is the sum of the static head and the friction head, and that the cylinder of a pump may be cracked under an excessive pressure thus developed.

Within the confines of a report of this character it is impracticable to discuss at further length the problem of water supply for concrete road work.

Cement—In the handling of cement there are two very common economic errors in evidence: (1) Failure to provide a large stock of cement; and (2) an attempt to locate the cement nearer the concrete mixer than is necessary. The concrete road builder is so often forced to wait for the delivery of cement by rail that he eventually learns that it pays to tie up more capital in a stock of cement than to foot the bills incident to delays in securing it by rail. Although cement dealers are usually prompt in making shipments, the railways are not always to be relied upon. For this reason, cement should be accumulated in stock-houses or stock-tents. Tents, with wooden floors made in sections, can be placed at short intervals along the road. From them the cement can be delivered in small gasoline motor cars of the kind that cost about \$500 each. Such a car will carry 10 bags or 12 bags of cement and can be run into the tent to be loaded by the driver of the car. The car will travel from 15 miles to 20 miles an hour loaded and 18 miles to 25 miles an hour empty, at a total cost of about 4 cts. per car-mile one way or 8 cts. per car-mile of effective hauling work. The resulting cost of hauling cement short distances can not be equalled in any other way known to your committee.

Sand—After the sub-grade has been sprinkled and compacted by rolling, it is customary to dump sand and gravel on it in piles. Then these materials are loaded into barrows and wheeled to the concrete mixer which travels along the sub-grade, leaving the layer of "green" concrete behind. This, we think, is at present the most common way of placing concrete. But it is not the only way, and

there are some contractors who maintain that it is not the cheapest way. Another method is to place both the mixer and the stock piles on one side of the road. The materials are then usually shoveled directly into the mixer, or into a bucket or skip, that delivers into the mixer. In the West it is not unusual to see Fresno scrapers used to drag the sand and gravel from the stock piles to the mixer. In some cases the scrapers deliver the materials upon a platform whence they are fed by gravity into a skip that delivers into the mixer. In these cases the mixer is not moved until about 600' to 1,000' of road have been built in both directions from the mixer, the concrete being hauled in one-horse concrete carts or in one-man concrete buggies.

The differences in cost between these two methods seem ordinarily not to be great; but there may be conditions that justify a choice of one method in one place and of another method in another place. Thus, if laborers are scarce and mules or horses plenty, the latter method may be preferable.

As above stated, a small \$500 motor car can be economically used to haul cement short distances. To do this, the body of a pleasure car is removed and a platform placed on the rear part of the chassis. This method of hauling cement was first devised by one of your committee, it is believed; and he now suggests that the same method might be advantageously applied in hauling concrete from a mixer to the road. To do this, a concrete bucket would be mounted on the chassis and the concrete would be discharged from the bucket through a trough. It might be desirable, in using such a method, to provide a pair of trussed planks that would span the road and be used as a runway for the automobile.

So much has been written about the unloading of cars of sand, etc., with drag scrapers, clam shell buckets, and the like, that we shall not here go into these labor saving methods. An ingenious modification of old methods was recently described. It consists in dumping sand or gravel from a hopper-bottom car into a pit dug beneath the track. The materials are thence dragged with a power scraper up an incline and dumped into a bin. This method has much to commend it where hopper-bottom cars are available.

Gravel and Stone.—Although cement and even sand may be rehandled without adding greatly to the cost of a concrete road, an attempt should always be made to avoid rehandling the gravel or broken stone. Broken stone is particularly hard to shovel up when dumped on the ground; and, besides, it constitutes such a very large part of all the materials to be handled. Stock piles of sand may often be needed to avoid delays in freight shipments; and, in such cases, they may be placed at relatively short intervals along the side of the road. If broken stone, or gravel, is also received by rail, it is generally wise to build the stock pile at the place where the cars are unloaded. Then a clam shell bucket can be used both to unload the cars into the pile and to load the wagons from the pile.

If large stock piles of stone or sand are to be made along the road, care should be taken to scrape a smooth place upon which to build the pile. With a road machine and a roller, a place can be so graded and compacted that very little of the material in the stock pile will be lost. Care should be taken to

locate such stock piles where heavy rains will not wash the materials away.

In the handling of broken stone from portable rock crushers, two economic errors are common: (1) Bins are too small, and (2) their bottoms are not steep enough. Small bins make it necessary to stop the crusher if there is not perfect co-ordination in hauling and using the materials. Bottoms that are flatter than 1 to 1 prevent the stone from running rapidly, and thus delay the loading. This last is important enough with team-hauling, but it is much more important where motor trucks or traction engines are used.

Hauling by Power.—Although the horse and the mule will long continue to be used on road work, their "day" for hauling road materials is fast passing. We have already given some details relative to the use of small motor cars for hauling cement short distances. Motor trucks of 3-ton to 5-ton capacity are becoming popular for hauling wherever the roads are sufficiently good to admit their use. Recently the use of "trailers" has added much to the popularity of motor trucks. While a "trailer" decreases the speed of transportation it greatly increases the tonnage hauled each trip.

Traction engines hauling trains of wagons have been in successful use for so many years that we need say little about them.

As to the relative economic merits of motor trucks and traction engines, no data yet available point either to the one or the other as being clearly preferable. In making comparisons, several things, other than the ton-mile costs while hauling during the road building season, should be kept in mind: (1) Whether or not the hauling plant can be used for other purposes than road building; (2) whether or not it can be used in the winter; (3) whether or not it destroys existing roads and sub-grades sufficiently to be objectionable; (4) whether or not there is room to maneuver—turn around, etc.

Not a few men are making it their sole business to contract for hauling. Such men often work their hauling plant two shifts daily, running about 18 hrs. out of the 24. This greatly reduces the interest cost per ton-mile. A not uncommon price is 15 cts. per ton-mile over rough roads and under severe conditions.

Following the report of the committee the discussion was led by Louis Hellmann, Chicago manager, Orenstein-Arthur Koppel Co., who read a paper on the use of portable tracks and cars in conveying materials, giving some data on work in Wisconsin and Illinois and showing stereopticon views of the operations. The small cars are either pulled by horses or moved in trains by small locomotives, with the advantage of having no interference with the work because of weather conditions.

There was also discussion of stock piles on planking as preferable to dumping sand and stone or gravel along the road. It was pointed out that great care in getting clean materials is partially nullified by the fact that the distribution of materials along a road results in taking up a certain quantity of soil with the aggregates.

Mixing and Placing

The committee on Mixing and Placing Materials was composed of Paul D. Sargent, ch. engr., State Highway Commission, Augusta, Me.; Arthur H. Blanchard, prof. Highway Engrg., Columbia Univ.; and C. W. Boynton, insp. engr., Universal Portland Cement Co., Chicago. The report as presented by Mr. Boynton was as follows:

In the construction of concrete roads, probably no really important part of the work is given less consideration, in specifications and in the field, than the actual mixing and placing of the concrete.

The following notes, based upon observations in the field, and the results of tests, were prepared with a view of pointing out the difference between good and bad practice, and to serve as a basis for recommendations covering this phase of the work.

The Mixer.—The concrete mixer should be of the batch type provided with an automatic water tank, traction drive and power loader. Mixers having a boom and bottom dump bucket of sufficient size to convey one complete batch for placing the mixed concrete, are preferred. However, buckets of other types and sizes, and open troughs can be used and will give good results.

Experience shows that where a tube or spout is used for delivering concrete, it is necessary to mix the concrete too wet for the best results. Another objection to this system is that it may be operated like a continuous mixer, the supposition being that, as the spout is provided with blades and revolves, the materials are mixed in the spout. This spout serves only as a conveyor and cannot to any degree take the place of or serve as a mixer.

The mixer should be provided with a suitable automatic water tank which can be quickly filled and emptied, so that when once determined, the required amount of water can be added to each batch of concrete. A number of so-called automatic tanks on mixers are not satisfactory owing to their limited capacity, delay in filling and emptying, and to the fact that they depend, for successful operation, upon a constant water pressure. Water is pumped on most road jobs, with small gasoline steam pumps, and it is not possible to maintain uniform pressure in the feed line.

An automatic measuring tank of the required capacity, that may be emptied quickly, connected by means of a comparatively large pipe, with an auxiliary or storage tank of about 50 gals. capacity, would be more satisfactory than the one tank system commonly used.

Where necessary to keep from cutting up the sub-grade and to facilitate moving, the wheels of the mixer should be run on suitable planking. Material of good quality 3" thick by 10" wide, in comparatively short lengths with square ends, will be found satisfactory for this purpose.

The power loader or skip should be of sufficient size to hold all the materials required for the batch. In charging the skip a part or all of the coarse aggregate should be placed first, and the cement, fine aggregate, and remaining coarse aggregate, if any, on top of this. All the cement should be in the skip

TABLE 1—CAPACITY AND SPEED (R. P. M. (REVOLUTIONS PER MINUTE) OF PAVING MIXERS

Name of Mixer	Rated Capacity cu. ft. unmixed cement material 1:2:3 Mix of Drum	Capacity Bags of R. P. M. of Drum	Name of Manufacturing Company
Austin Cube	14	2	Municipal Engineering & Contracting Company
Chicago Mixer	22 10 14 23 30	3 1 2 3 5	Chicago Concrete Machinery Co.
Smith Mixer	14 23 34	2 3 5	T. L. Smith Co.
Footo Mixer	7 13 23	1 2 3	Footo Concrete Machinery Co.
Koehring	7 12 20 24	1 2 3 5	Koehring Machine Co.
Oshkosh Milwaukee	18 8 14 20	1 1 2 3	Oshkosh Manufacturing Co. Milwaukee Concrete Mixer Co.
Ransome	10 18 21 28	1 3 3 4	Ransome Concrete Machinery Co.
Standard	7 15 21 30	1 2 3 5	Standard Scale & Supply Co.
Chain Belt	10 16 15	1 2 2	Chain Belt Co.

before the last of the aggregate is added. If charged in this manner there will be less tendency for the materials to stick in the skip when emptying and less loss of cement on windy days. A systematic method of loading the skip will also serve as a check on the right amount of material being placed each time.

The filling of the skip is accomplished in practice in two ways—by the use of wheelbarrows and by shoveling direct from the supply piles into the skip. This latter practice, however, should be discouraged, for accuracy is impossible, and it encourages carelessness. Besides, the entire loading gang loses time waiting while the skip is raised and lowered.

Mixing Concrete—No important operation is given less attention than the mixing of the concrete. Frequently in practice, the time the materials remain in the drum is governed only by the speed of the gang charging the skip. At times the batch mixer is operated practically as a continuous mixer, by fastening the discharge scoop or spout so that there is a constant flow of concrete from the mixer.

The quality of concrete is largely dependent upon thorough mixing. To insure thorough mixing the revolutions per min. of the mixer and the time the complete batch, including water, remains in the mixer, should be specified. To specify either the r. p. m. or the time is not sufficient as is plainly shown by the following tabulation of field observations:

Job	Mixer	R. P. M.	Mixing Time
1	Smith	10-C	1½ min.
2	Koehring	18	40 to 45 sec.
3	.....	18	30 sec.
4	Footo	14	45 sec.
5	Edipse	13	2 min.
6	Austin Cube	16	50 to 55 sec.
7	Smith	11-C	2 min.
8	Chicago	24	30 sec.
9	Footo	18	25 sec.
10	Koehring	18	20 sec.
11	Austin Cube	16	20 to 60 sec.
12	Koehring	32	15 sec.
14	Austin Cube	16	10 sec.
15	Ransome	7	1 min.
13	Koehring	18	20 sec.

Upon inquiry of the manufacturers it was found that the r. p. m. of the drum of batch mixers varies for different make, as shown by Table I compiled from data furnished by the manufacturers.

Because of the shape and arrangement of the interior of the drum, the rate at which a given mixer is operated has a direct bearing upon the quality of the concrete, therefore the drum should be operated at approximately the speed at which the manufacturer claims the best results would be obtained.

It is recommended that all specifications contain a clause to the effect that all the materials in any one batch—including the water—should remain in the drum of the mixer at least 45 sec. before any of the concrete is discharged.

In all cases the drum should be completely emptied before the next skip of materials is dumped into the mixer. This is a source of constant controversy between the engineer or inspector and the contractor, especially where the mixer is used equipped with an open trough, or with a boom and bucket when the bucket is not large enough to hold the whole mixed batch.

The operator should start the water into the drum as soon as the skip is in position to dump—that is, it is not neces-

sary to mix materials dry before adding water.

Consistency—The practice on road work is to mix concrete entirely too wet. This causes a separation of the coarse materials from the mortar, resulting in stony pockets throughout the concrete. Where the concrete is mixed too wet, it is practically impossible to obtain and hold the required crown, and stony patches frequently appear on the surface after it has been finished, owing to the flow of water and mortar to the sides. In striking off and floating concrete mixed with an excess of water, it is also practically impossible to obtain a surface of the desired character, as the excess of water collects in and hides depressions and other inequalities in the surface, which cannot be corrected, as they are not apparent until after the water has evaporated.

In addition to the difficulty encountered in getting wet concrete into the pavement in a manner which will give the best results, laboratory tests and results observed in the field show that, other things being equal, a wet mixture is of inferior strength and quality to concrete of a medium wet consistency. The marked effect on the strength of concrete that a variation in the consistency produces, is shown in the following table of tests made in the Sheffield Scientific School of Yale University by Chas. J. Robinson. See *Engineering News*, Vol. 69, No. 21, May 22, 1913.

% Water	7 Das. ¹	30 Das. ²	60 Das. ²
20	2052	2777	3194
22½	2178	3132	3305
25	2277	3278	3388
27½	2500	3516	3597
30	1722	2574	3166
32½	1413	2181	2666
35	1222	1977	2388
37½	1097	1819	2173
42½	652	1500	1888

¹One test only

²Average of two tests

In this test water was added from 20% to 42% according to the following method:

"As a minimum enough water was taken to moisten the stone and sand, and then there was added 20% (of the amount of the cement by weight) water. Each subsequent mixture was increased 2½% water. It was noted that the 42½% mixture was about as wet as is used in the average wet mixture, though drier than some slushy mixes."

As yet there are not sufficient data on which to have a definite conclusion relative to the influence of the consistency of concrete upon the expansion and contraction; however, information at hand seems to show that this action is influenced very largely by the consistency.

Owing to the methods employed in striking off and finishing the surface of concrete pavements, there is little likelihood of mixing the concrete too dry. Concrete mixed with an excess of water is easier to mix, to handle, to place and to finish, than concrete of the proper consistency, which explains the tendencies toward wet mixtures.

The amount of water in the concrete should be such as to cause it to settle to a flattened mass when dropped from the bucket, but not sufficient to cause it to flow readily on the sub-grade. The consistency should be such as not to require tamping, but not so wet as to cause a separation of the mortar from the coarse aggregate in handling and placing. If there is an excess of water on the surface, or the mass has a tendency to flow or settle out of position after being floated, the concrete has been mixed too wet.

Placing Concrete—Just before placing concrete, the sub-grade should be well sprinkled so that it will not absorb moisture from the concrete, and should be checked by the engineer or inspector to make sure that the required thickness of concrete can be placed. Checking the sub-grade may be done by the use of a straight-edge or line, resting on, or stretched from the top of the side forms.

Probably the most satisfactory method of depositing the mixed concrete in position on the sub-grade is by means of a bottom dump bucket running on a swinging boom from the mixer. The boom can

be swung over any position on the sub-grade, and the bucket can be run out and dumped at any point along the boom. Such equipment does not depend for economical operation upon consistency and the concrete can be easily handled and deposited at any place on the sub-grade, necessitating but little handling with shovels. Between two changes in position of the mixer a section the full width of the pavement (up to $1\frac{1}{2}$ times the length of the boom, and as long as the boom), may be concreted.

When concrete is placed by means of the open trough care must be exercised to see that it is not mixed too wet, as this method of distribution depends for economical operation very much upon the consistency of the concrete. An open trough is necessarily much shorter than a boom and is more limited in action, which requires that the mixer be moved ahead more often, also that more of the concrete after being deposited on the sub-grade be handled with shovels.

When a batch mixer, not having a boom and bucket or open trough, is used, the concrete should be handled in wheelbarrows or hand carts wheeled on suitable runways. Placing concrete by means of horse carts should not be permitted as they cut up the sub-grade badly and to get the concrete into final position requires a maximum amount of shoveling.

Whatever the method of conveying and placing, the concrete should be deposited upon the sub-grade to the required depth and for the entire width of pavement in as nearly one operation as practical so as to reduce handling to a minimum. If it is necessary to handle a large amount of material with the strike-board it will ride the concrete and thus produce a wavy, uneven surface. Attention to this matter will materially lessen the difficulty and labor in striking off the surface and will result in a very much better finish.

The excess of coarse material that accumulates in front of the strike-board should be uniformly distributed over the surface of the pavement and not left in narrow strips across the section, or placed along transverse expansion joints. An ordinary garden rake will be found useful in distributing the material that accumulates in front of the strike-board. When the strike-board is within 2' of an expansion joint the excess material that has accumulated in front of it should be removed with a shovel and deposited on the sub-grade in the next section. Special care should be taken to place good dense concrete along expansion joints, and all inequalities at the joints, including any small holes left after the removal of the installing device, should be filled with a mortar composed of 1 part cement and not more than 2 parts fine aggregate.

The man handling the strike-board should follow closely behind those placing the concrete, for keeping up with the strike-board will materially assist those placing concrete in depositing the required amount of material.

The placing of concrete should be a continuous operation, and stops should be made only at expansion joints. In case the mixer breaks down concrete should be mixed by hand to complete the section, or an expansion joint should be placed at the point of stopping work. Any concrete in excess of that needed to complete the section, when work is discontinued, should be spread out in a thin layer, not exceeding 2" in thickness, over the sub-grade in the next section and not piled up along the expansion joint.

The strike-board should be cut to con-

form to the crown of the finished surface of the pavement and should be of sufficient strength and stiffness to show no deflection at the center when supported at the ends, nor a material bowing out of alignment when in use. It should be about 2' longer than the width of the road, protected on the bottom edge with a metal facing and provided at each end with suitable handles.

For roads up to 12' in width two 2-in. x 6-in. planks, dressed on one side and both edges, spiked together, made a good strike-board, and for roads 12' to 20' in width two 3" x 8" or a 2" x 10" and a 3" x 10", spiked together, will be found satisfactory. Two planks, well spiked together, make a better strike-board and one less likely to warp out of shape than a single piece. The strike-board should not be so heavy that it cannot be easily handled by two men, and to reduce weight and increase stiffness, it is advisable on work over 20' in width to use a strike-board composed of boards 2" or 3" thick, stiffened by trussing, rather than obtain the required stiffness by the use of heavier timbers.

In striking off a pavement 16' or less in width, where the concrete has been properly placed, two men should be able to handle the strike-board, but for wider pavements the services of a third man will be required to assist in pulling the board forward by means of a drag line fastened at its center.

The strike-board should always be worked forward about perpendicular to the axis of the roadway and as it is moved ahead should be sawed back and forth across the road.

To produce the desired effect will require that the strike-board be passed over the surface of the concrete two or more times.

Though it will be necessary for the workmen to get into the concrete some after it is deposited on the sub-base, it is desirable that all unnecessary walking in and wading through the concrete be avoided, and under no circumstances should any workmen step upon the concrete after it is first struck off.

In the discussion J. S. McCullough, city engineer, Fond du Lac, Wis., did not favor specifying 45 sec. in the mixer for each batch but proposed that the mixer should be given no more than 20 r. p. m. and that each batch be given no less than 10 turns. He insisted that the number of turns determined the mix and not the time in the mixer. Mr. McCullough specifies a "pasty" not a "soupy" mix—a mix which will not flow from a wheelbarrow unassisted by a shovel.

Thickness, Crown and Grades

The committee on Thickness, Crown and Grades was composed of Leonard C. Smith, University of Wisconsin, Madison; Earle R. Whitmore, City Engineer, Port Huron, Mich.; and T. R. Agg. Asst. Prof. in civil engineering, Iowa State College, Ames. The report presented by Mr. Smith follows:

Even the hurried and incomplete examination of the literature concerning thickness, crown and grades of concrete pavements discloses the fact that a very considerable variation in practice has existed in the past. In fact, in view of the many local factors which must and should control such details, we do not see how in the future it will be possible to standardize such matters, except to a limited extent.

The observations of your committee indicate that future failures in concrete pavement are more apt to result from a lack of faithfulness and skill in the selection of materials and their proper incorporation into the pavement in a workmanlike manner than they are from improper details of design. It must be admitted that the greatest obstacle in securing excellent pavements of any type is the difficulty in securing competent inspection. This is particularly true of concrete pavements because of past conditions too well known to need discussion here, but growing out of the careless and unskillful manner in which concrete for pavement foundations has been constructed.

A review of present practice of any art is usually illuminating and in case of a comparatively new structure—like the concrete pavement—is likely to be of considerable value.

THICKNESS

The thickness of the concrete pavement is controlled by many factors, such as condition and character of the sub-grade, drainage, traffic, climatic conditions, width of pavement, etc. Three distinct types of cross-sections are in general use:

A. Uniform thickness of concrete for all widths of roadway, and consequently with the same amount of crown in the foundation as in the surface.

B. Roadways in which the concrete is thicker at the center than at the edge but in which some crown is given to the foundation.

C. Concrete roadways in which the concrete is thicker at the middle than at the edge, but which are built upon a flat sub-grade. This type seems to be fast gaining in favor.

In one of the publications of the Assn. of Am. Portland Cement Mfrs., entitled "Concrete Highways," may be found a table giving data on the thickness of about 600 concrete pavements in this country. In Appendix I' may be found some additional information on this point, collected by the committee.

It will be seen from these data that the thickness of concrete pavements varies from 6" to 8" at the crown line and from 5" to 8" at the edge. The necessity for the greater thickness is perhaps more urgent in the northern than in the southern parts of the U. S., because of the greater extremes of temperature. Because of the growing tendency to increase the size of the loads, it seems reasonable to suppose that we have not yet reached the extreme limit of thickness required.

Because of the fact that the members of this committee have had their attention directed chiefly to the conditions obtaining in the northern states, it is not without some misgivings that they suggest the following as conforming to the best practice:

1. Where the width of roadway is not greater than 16', with a porous sub-soil, sub-grade in good condition and well packed and with loads not exceeding six tons, including the vehicle, a thickness

of 5" at the edge of the slab and 7" at the center is sufficient without reinforcement, using slabs not greater than 16' x 16'.

2. On clay soil and the above general conditions artificial drainage should be provided and reinforcement used ($1\frac{1}{2}$ lb. to $\frac{1}{2}$ lb. per sq. ft.), placed $\frac{1}{2}$ " to 2" from top surface; and slabs made not larger than above and not less than 6" thick at edge of slab and 8" at the center.

3. Where the roadway is in excess of 16' with loads of 6 tons to 10 tons but with the other general conditions as described in (1), the crown of the pavement should have a thickness of 8" and the edge 6". Under such circumstances reinforcement will usually be considered necessary and economical.

CROWN

Unlike some types of pavements, those of concrete are undamaged by water, unless it finds its way to the sub-grade. However, since even thin sheets of water or ice on the surface of any pavement are objectionable, a sufficient crown must be provided to insure the unwatering of the pavement. Theoretically, with a perfectly surfaced concrete, a very slight side fall only is required to accomplish this. Practical experience in such construction, however, has demonstrated the great difficulty in preventing small imperfections and depressions in the surface, therefore sufficient cross fall must be provided to insure their drainage. The difficulty of accomplishing this is increased because of the suspension of large amounts of dust in the street water.

Attention is directed to the fact that on city streets with side curbs we face a different problem from that found in a narrow country road without curbs. In the city street the crown must not only be sufficient to cause the water to run from the center to the side of the pavement, but also enough to insure that an undue proportion of the pavement shall not be covered by water. This requirement is aided if the pavement is given a "peaked" crown, i. e., say $\frac{3}{4}$ " of the total rise at $\frac{1}{4}$ distance from center to curb, and $\frac{1}{4}$ " at half the distance.

The small crown that may be properly used on concrete pavements is justly considered an important merit of this type of pavement. Data have been collected which seem to show that in the case of uniformly thick concrete pavements the amount of central longitudinal failures has varied directly with the amount of crown. To a lesser extent this would be expected of the other types, thus furnishing an additional reason for the adoption of a minimum crown.

In Appendix II¹ will be found the practice regarding crowns in about 30 cities, from which it appears that the minimum crown used on streets is 1/160 of the width of the road and the maximum 1/48. With few exceptions, the crown varies between 1/70 and 1/100 of the width. When the climatic conditions will allow, it is our opinion that a crown of 1/100 of the pavement width represents best present practice. The use of the high crowns has in large part resulted from past experience with other types of pavements where high crowns were really required. We are of the opinion that in future construction, as methods of handling materials are improved and contractors become more experienced, en-

gineers should not hesitate to specify as low a crown as 1/150 part of the width. Indeed, this has already been done to some extent.

GRADES

The committee has been unable to find any reliable data on the relative slipperiness of concrete pavements. It is greatly to be regretted that such information is not at hand. In view of the ease with which tests of this nature could be made and the importance of such knowledge in the design or selection of pavements, we recommend to this convention that experiments along this line be undertaken.²

From such observations as we have been able to make, we see no reasons why a concrete pavement, properly finished, may not be used on grades as steep as any other hard surfaced pavement, and on steeper grades than either wood or asphalt. On grades steeper than 3% or 4% shallow corrugations in the surface will be found of much assistance—in fact, with grades of 5% and over, a real necessity.

In the discussion which followed there was evident considerable favor for the dished sub-grade as proposed in a previous report by Mr. Wig. It was contended that Europe uses much thicker pavements. It was also suggested in the discussion that No. 7 triangular mesh reinforcing is not heavy enough greatly to decrease the number or size of pavement cracks.

F. P. Wilson suggested in the discussion that the same thickness should be used throughout the slab in city pavement work, although a slab thinner at the edges is satisfactory for country roads. He said that a flat sub-grade is unsatisfactory for city streets as it does not take care of drainage. Mr. Wilson said concrete is the least slippery of all pavements. He advocated finishing with a rip-sawed wooden float but said pavements should not be corrugated even on grades. In further reference to the dished sub-grade Mr. Wig said that the result would be a contraction "down hill" toward the center and that subsequent expansion "up hill" would be restrained. He also explained that a wedge action toward the center would result in a firmer hold upon the sub-grade.

Trading in Stolen Cement Sacks

No honest man wants to be a receiver of, or dealer in, stolen property. Sometimes, particularly in our larger cities, contractors or cement dealers are given the opportunity of buying at a ridiculously low price a quantity of sacks of the brands that they handle. A transaction of this

kind naturally seems to be simple and profitable. To buy for 6 cts. apiece sacks that can be sold for 10 cts. looks like a pretty good stroke of merchandising. As a matter of fact, such a practice is not honest, and in the long run it is not profitable. No one holding a regular title to cement sacks sells them to a dealer or contractor for 6 cts. when he can sell them direct to the cement company for 10 cts. If sacks offered at a reduced price are traced back to their source, it will generally be found that they have been picked up by junk dealers from people who have stolen them, or that they have come from some bankrupt or questionable business methods who is seeking to realize something from the sale, at a reduced price, of sacks for which he himself has not yet paid. Neither are such transactions profitable in the long run, because they create a market for stolen sacks. "A" may realize today some slight illegitimate profit by trading in sacks that have been stolen from "B," but since a market has been created for stolen sacks, how is "A" to know that he, himself, may not be the victim tomorrow, and that sacks stolen from him may not be offered to someone else, or even to himself, at a reduced price? Everyone in the cement business, either customer or dealer, has certain legitimate and clearly understood sources of income and profit. Trading in stolen sacks is not one of these, and everyone engaged in handling cement owes it to himself, as well as to his associates, to discourage the theft or misappropriation of sacks, by refusing absolutely to give the thief a market for his loot.

Boston's New Dry Dock

At a recent hearing to determine the advisability of using concrete for the immense new dry dock, forming part of Boston's port development, photographs of reinforced concrete piers, built by the Aberthaw Const. Co., Boston, in 1909, formed one of the determining features. These photographs showed that with proper mix and treatment the combined chemical and frost action of sea water could be neutralized even when the material was subjected to alternate immersion in the water and exposure to the air. The decision was to build of reinforced concrete with wearing surfaces or altars of granite.

A bed at home is worth two in a hospital.

²Perhaps such work can best be done under the guidance of some University because of the need of unbiased and impartial tests

¹This Appendix is here omitted—Editors

The Use of Hydrated Lime in Concrete Mixtures for Pavements¹

By ROBT. S. EDWARDS²

It is the purpose of this paper to show wherein certain materials, when put together carefully and correctly, serve to make and meet beyond any question of doubt a pavement which has become a recognized standard under practically all conditions of cost, labor and materials. Such a pavement, when properly laid, has demonstrated itself to be permanent under all varying conditions of traffic.

Concrete pavements meet all of the above requirements, but the concrete pavements of the future must be so put together in their making as to leave no room for doubt to even the most skeptical. It is in this putting together of a concrete to be used for a pavement that the manufacturer of hydrated lime is bound to find an ever increasing demand for his standardized hydrate.

The utilization of concrete as a paving material during the last five or six years has developed into an extremely important business, and is destined to become one of the greatest, if not the greatest consumer of Portland cement. Concrete pavements are found in practically all states in the Union, while the various counties of several states have practically standardized this pavement. Notable among these is the County of Wayne, which includes the city of Detroit, Mich. Since the inception of concrete road building in Wayne county, about five years ago, more than 70 miles of concrete pavement have been laid, and the county long ago adopted concrete as its standard pavement. As this county has placed more concrete pavements, and of necessity has had more actual experience in handling concrete pavements than any other section of the United States, it is interesting and instructive to know what its specifications call for and how experience has taught its officials to do their work.

1. Great care is taken in preparation of the sub-base. Experience has shown that more cracking in concrete pavements has resulted from improv-

er and careless treatment of the sub-base than from any other one cause for cracking; consequently the sub-base is rolled hard and made as uniform as possible; also density is desired so that water seepage from the concrete into the sub-base may be diminished as much as possible.

2. Careful specifications for the sand, gravel or crushed rock and cement are insisted upon and carried out to the letter. Careful proportioning and mixing of the concrete are also done.

3. Within the last four years a gradual increase in the richness and thickness of the concrete has been specified and the present specifications call for a 1:2:3½ concrete mixture 7½" thick for a one-piece concrete pavement.³

4. Care in protecting and covering all concrete after placing and keeping it covered for at least 10 days. This precaution is taken to prevent the loss of moisture by evaporation from the surface of the concrete.

5. The use of steel expansion joints cutting the entire depth of the concrete at each 25-ft. section and the filling in between these sections as formed, by pieces of asphalted felt.⁴

Placing and treatment of concrete pavements under the above specifications have produced results which are very satisfactory, and in carefully analyzing these specifications it would seem that every particle of engineering and common sense had been used. In practically every step in the process of laying the concrete it has been the intention to carry on the work so that future cracking may be eliminated, yet in spite of all these precautions more or less cracking has developed and is generally attributed to settlement of the sub-base or the movement of the concrete, due to temperature changes.

From the writer's experience, gained in the testing of materials

which go into concrete, as well as from experience acquired in the supervision of important concrete work and examination of so-called "concrete road failures," he does not believe that the fundamental causes for cracking in concrete pavements are temperature changes in the concrete or settlement of the sub-base alone. There are other primary and extremely important reasons why these so-called temperature and settlement cracks develop at a later date, and until we take proper steps and exercise due care to the right time, we cannot greatly reduce this excess cracking.

No specification for laying concrete pavement, to his knowledge, has taken into consideration the chemical peculiarities shown by Portland cement concrete in its preliminary setting and hardening periods. There has been no special provision for retaining to as large a degree as possible the actual mixing water first used in the concrete mixture. By careful treatment of the sub-base and protection of the finished surface of the concrete after pouring, it is the intent of the various specifications with which the writer is conversant, to retain in the concrete as much of this first mixing water as possible. While these precautions are a great help, they are not quite sufficient, as they rely to a great extent on treatment of surfaces to keep the water from leaving the concrete. The prevention of this leakage of water from concrete after the first few hours in which it is poured is an extremely important feature, and in this connection it is well to bear in mind that the reaction between a solid, such as Portland cement, and a liquid, such as water, is a surface reaction, water being able to react on the surface of the cement grain only, and that owing to the slowness of the reaction and the insufficient amount of water being present, *only a relatively small amount of the Portland cement is at first decomposed by water.* Consequently if we can actually keep within the concrete mass what little excess mixing water we start with, or introduce into the concrete mass in the mixing some substance that contains or will readily hold excess water which the cement may secure later, we shall accomplish what has not been done before.

There is no more important period in placing a concrete road surface than the first 24 hrs. after pouring the concrete, for it is in this period that minute spots of weakness generally develop, due to the loss of water by leakage and evaporation and use

¹Portion of paper presented at meeting National Lime Mfrs. Assn., N. Y. C., Feb. 4-5, 1914

²Consulting and Chemical Engr., Portland, Ore.

³A 1:1½:3 mix is used and a thickness of 6" at the sides with a crown of 1½" to 1", giving a thickness ordinarily of 7½" at the center.—Editors

⁴The steel plates, being only 3" deep, do not extend the full depth of the concrete.—Editors

of water by the cement in setting, causing contraction in the first 24 hrs. Upon the later permanent hardening of the concrete, we do not secure a slab of so great cohesive uniformity as would be expected on first consideration.

The general conditions under which concrete pavements are placed are severe, as the majority of work is usually done in the dry spring and summer months when temperatures are high, causing excessive evaporation. The concrete is generally poured on an earth or clay sub-base in a thin slab varying between 4" and 7" in thickness. This condition alone makes it almost impossible to secure uniformity throughout the concrete mass, so that after hardening the concrete road slab is subject to far greater variation, due to the segregation of the coarse aggregate from the mortar, than is found in other forms of concrete work. This, of necessity, causes unevenness throughout the concrete, and the excessive cracking and unraveling so often seen in poorly laid concrete roads is directly due to this fact.

It is the writer's opinion that the primary cause of cracking in concrete pavements is due to the loss or leakage of varying portions of the mixing water from the concrete by seepage through the sub-base, as well as by evaporation from the surface of the concrete, which leaves the concrete road slab in such a condition that at later times it will alternately absorb and give up water, depending on the season of the year, and that expansion and contraction of concrete and any movement in its volume are due infinitely more to this alternate wet and dry condition than to any temperature change from hot to cold without presence of moisture.

That the cracking which is directly attributed to the change in the condition of the sub-base, either in settlement spots or in drying out in shrinking, is primarily due to this cause, which is greatly helped by unevenness and variability of the concrete mixture.

That there are extremely few, if any, concrete pavements, individual slabs of which can be considered entirely uniform.

THE USE OF HYDRATED LIME

Hydrated lime is a product formed by the addition of accurate quantities of water to known weights of freshly burned quicklime, the finished material being a flour-like powder of great fineness and covering capacity, having more than twice the volume of the same weight of cement in its dry state.

The use of hydrated lime as a void filler in concrete mixtures, and for rendering concrete mixtures more water-tight, dates back several years. Numerous tests show that a replacement of from 10% to 15% of cement by hydrated lime in rich concrete mixtures does not decrease the compressive strength of the concrete after three to four months' time, and ultimately increases the strength and permanence of the concrete. It apparently makes but little difference as to its action as a void filler, whether the hydrate is manufactured from a dolomitic or high magnesia lime or a high calcium lime—it being necessary only to have a product which contains no free lime or unslacked particles. The proper hydration or dry slacking of lime reduces it to a finer degree of subdivision than can be accomplished by any mechanical means.

The amount of water required to convert the dry hydrated lime into a plastic paste varies from 50% to 70% of the weight of the lime; while, to obtain a mortar of similar consistency with Portland cement, an addition of 25% to 30% of water is required.

Unlike Portland cement, however, the addition of water to hydrated lime does not create any chemical reactions. There is simply a lime paste formed which holds its excess water for a long time. Upon the addition of small quantities of hydrated lime, amounting to 10% or 15%, to the weight of cement used in concrete mixtures and the ordinary mixing of such mixtures, the hydrate, which has absorbed a large amount of water, corresponding to its weight, is thoroughly disseminated throughout the concrete mass, and, due to its fine plastic conditions, it is forced immediately into places in the concrete which the cement cannot reach.

Concrete, so mixed, on leaving the mixer, flows more readily into place and the coarse aggregate has much less tendency towards segregation in the concrete mass. In other words, the extremely finely divided condition of the moistened hydrated lime paste has increased, to a marked degree, the covering or spreading quality of the cement, and reduced, to a similarly marked degree, the friction between particles of fine and coarse aggregate.

This answers the question "Why does hydrated lime benefit concrete?" The action is purely a mechanical one, and can be compared to the oiling or greasing of a shaft or bearing. The property which hydrated lime has of absorbing and retaining large percentages of water

offers a ready solution to the problem of finding a means for keeping and holding moisture in freshly poured concrete pavements until the slower-acting cement-hardening process can utilize it.

It is obvious that small percentages of hydrated lime, when added to concrete mixtures, in road work, will accomplish the following things:

1. Renders the concrete highly plastic and homogeneous, thus producing density and uniformity in the finished concrete. This condition adds much to the life and efficiency of the road because of the uniform resistance to wear and other stresses.
2. Keeps a certain amount of excess moisture in the concrete while setting.
3. Renders the concrete mass more nearly water-tight, thereby preventing the alternate wetting and drying out of the finished concrete.
4. In large pieces of work, these properties given to concrete by hydrated lime would materially reduce the labor in spreading and bringing the concrete to a uniform surface, which is of great importance in paving work.

Concrete Beds for Machinery

If the use of concrete foundations is so satisfactory, why not use concrete beds for machine tools? Commenting on this editorially, a recent issue of *Mill Supplies* states that the cost of the present tools is largely a matter of labor, and asks if there is not a large cost attached to the making of the heavy and unwieldy castings made necessary by the beds and framework. This cost is multiplied in shipment and erection. In some cases the beds are made large merely for the stabilizing influence of weight. These could certainly be replaced by the cheaper concrete construction.

Removing Centering

From a draft for proposed standards and specifications for plain and reinforced concrete, which have been submitted by the Canadian Soc. of Civ. Engrs., the following notes on "Form Removal" are quoted:

The forms shall not be removed until the times named in the following table have elapsed after depositing concrete, not counting periods in which the temperature has been below 35° F.

Part	Minimum 24-hr. day
Posts under beams and girders.....	20
Floor-slab panels	10
Wall forms	2
Column forms	4
Sides of beams and girders.....	4
All other parts	10

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Prevention of Condensation on Concrete Roof Slabs

DISCUSSED BY ALBERT M. WOLF¹

"We have had considerable difficulty with the condensation of steam on the under side of a concrete roof. The water caused by the condensation drips onto the machinery and is quite an annoyance. We are now building an addition and wish you would suggest some way of obviating this trouble."

BY MR. WOLF

Wherever concrete roofs are used on buildings where steam-laden or moist air is to be found there is sure to be trouble due to condensation, especially in this northern latitude. Condensation occurs only when the room temperature is considerably higher than that of the outer air, or when the air becomes so heavily laden with moisture as to reach its dew-point.

In heated buildings condensation takes place if there is moisture present on all surfaces which are affected directly by the cold outer air. Concrete is generally considered to be a poor conductor of heat, but in roof construction, which is ordinarily quite thin, it is a relatively good conductor when compared with wood. This means that concrete roofs in such buildings must be insulated in some manner so that the temperature of the outer air does not affect the temperature of the slab and it is also necessary that the best of ventilation be provided. In some cases, even with perfect insulation, condensation will take place, if there is much steam present whenever the air

reaches the dew-point. Under such conditions the problem narrows down to one of providing adequate ventilation to carry away the moist air, thereby preventing condensation and consequent dripping.

In storage warehouses and buildings of a similar nature, where no artificial heating is required, condensation can be almost eliminated by proper ventilation. Buildings of this type may be classed among those requiring little or no insulation for concrete roofs. Power houses, paper mills, roundhouses and similar structures with concrete roofs, however, are a class of buildings which require the best of insulation and ventilation to prevent condensation. Between these two extremes lie many manufacturing and industrial buildings which, if built of concrete, will require a more or less positive type of insulation for the roof slab.

With these facts in mind it can be seen at once that it would be folly to use the same kind of insulation for all classes of buildings and expect to obtain good results and at the same time exercise economy. In one case, a certain method of insulation may meet all the requirements, while in another, on account of different conditions, the results may be entirely unsatisfactory. For this reason the writer will refer so far as possible to the particular kind of condensation insulation which is applicable to each type of building.

The types of insulation to be discussed are as follows:

1. Roofing felts and quilts
2. Cinder fill (with cement finish upon which the roofing is laid)

3. Cinder concrete fill (covered with roofing)
4. Hollow tile (with mortar top coat upon which roofing is laid)
5. Combination hollow tile and cinder fill
6. Double concrete roof (light concrete slab above the main roof slab)
7. Suspended ceilings.

ROOFING FELTS AND QUILTS

If the concrete roof is pitched or sloped to provide for drainage and the building is to be used for ordinary light manufacturing, warehouse or storage purposes and very little steam or moisture is present, a heavy roofing quilt or insulator placed under the tar-and-gravel or prepared waterproof roofing, will furnish sufficient insulation. Such insulation is easily applied, is of light weight and low first cost. The cost, in general, amounts to about 1¼ ct. per sq. ft., in place. It has a disadvantage which somewhat offsets the low cost, that of being soft and cellular and therefore easily pierced or broken down, thus destroying its insulating value and necessitating a renewal.

CINDER FILL

One of the most common methods of insulating roofs is to place a fill of steam boiler cinders on the roof, pitched to provide for drainage and covered with a coating of cement mortar about 1" thick upon which the roofing is placed. This method of insulation permits the use of a level roof slab, which in itself, is quite a saving. The extra cost of formwork with a roof sloped in one general direction amounts to about ½ ct. to 1 ct. per sq. ft., while if the surface is warped this extra cost will amount to 3 cts. or 4 cts. per sq. ft.

The cinders, which should be a porous grade of steam boiler cinders free from refuse or slag, should be wet down thoroughly, then placed on the roof, arranged to the proper slopes and tamped to an even surface. The minimum thickness of cinders at any place should be not less

¹Asst. Engr., Condron Co., Struct. Engrs., Chicago

than 3". Before the cinders have had a chance to dry out a 1:3 cement mortar coat, mixed quite wet, should be placed on the cinders to a depth of about 1" and given a smooth float finish. After the mortar has thoroughly set the roofing may be placed.

It is essential that the cinders be wet down before hoisting to the roof, for if this is done after placing on the roof slab the excess water will stand on the slab and cause trouble by seeping through the ceiling. If the cinders are not wet down before placing they do not tamp well and when the surface finish of cement mortar is applied, the dry cinders will take up the water in the mortar and decrease its strength and value.

With insulation of this sort it is necessary to provide for expansion of the top surface. The top portion of the fill and the mortar finish should therefore be kept 1" or so from all parapet walls to allow for expansion joints to be filled with some bituminous or asphalt paving pitch.

A cinder fill weighs on an average from 65 lbs. to 75 lbs. per cu. ft., and it is therefore important that the downspouts be so arranged as to keep the average depth to a minimum, which will usually be about 12". The cost of this type of insulation for an average depth of 12" is about 9 cts. or 10 cts. per sq. ft.

This insulation is solid enough to bear all the usual weights coming upon it, gives no trouble from expansion and can be readily used on concrete slabs which are designed as future floors in case of the desire for the addition of future stories, because of the ease with which it can be torn up and re-used. It has been used extensively on concrete warehouses and manufacturing buildings and is a very satisfactory insulation for any type of building except power houses, paper mills and other similar buildings where much steam is present.

CINDER CONCRETE INSULATION

A porous cinder concrete mixed in proportions of 1 part by volume of cement to 8 parts or 10 parts of porous screened steam boiler cinders has been used to a considerable extent as an insulator. It should be placed carefully so as not to lose the porosity, in much the same manner as a cinder fill, and finished off with a mortar coat on which to lay the roofing. Expansion joints should be provided at all walls the entire depth of the fill, since on hot days such a fill expands and exerts considerable pressure. Many parapet walls have been pushed out of the place because

of failure to observe this rule. A cinder concrete fill insulation should primarily be very porous, with a rich mortar finish to seal the dead air space in the fill.

A cinder concrete fill is not so efficient an insulator as a cinder fill, the cost is higher and the danger of expansion is greater. The excessive weight, about 100 lbs. per cu. ft., is the main disadvantage, which means that the roof construction must be considerably heavier in order to carry the load. The cost of the cinder concrete fill with an average depth of 12" will vary from 13 cts. to 15 cts. per sq. ft., depending on the height of building and the cost of cinders.

HOLLOW TILE INSULATION

Hollow clay tile laid on a concrete roof slab and covered with a cement mortar finish upon which the roofing is laid, form a good insulation against heat and cold and resulting condensation. The tile used are 3" or 4" thick, of the ordinary soft clay partition tile variety, with scratched surfaces to furnish a key for the cement mortar surfacing about $\frac{3}{4}$ " or 1" thick. The tile should be laid end to end to form continuous air spaces, with tar or asphalt expansion joints at all walls.

This insulation can be used on sloping roofs only and in fact is the ideal one for such roofs, since it combines the advantages of light weight (32 lbs. to 35 lbs. per sq. ft.) comparatively low cost and positive insulation. It can be constructed very rapidly and easily and can be used for almost any type of structure. The average cost of this construction will be about 10 cts. to 12 cts. per sq. ft.

COMBINATION HOLLOW TILE AND CINDER FILL

Without doubt the best insulator is the combination hollow tile and cinder fill, for it combines and augments the advantages of each method considered separately. It is constructed in the same manner as the cinder fill except that the hollow tile are first placed end to end on the roof slab, and the cinders and mortar finish placed thereon. The weight of this construction for an average depth of 12" amounts to from 70 lbs. to 75 lbs. per sq. ft. and the cost is about 12 cts. to 13 cts. per sq. ft.

This insulation is as nearly perfect as can be made without the use of expensive cork insulation combined with tile, etc. For power houses, paper mills, roundhouses and structures of a similar nature it is as nearly positive as can be constructed, and with proper ventilation no trou-

ble should be experienced from condensation. The dead air space directly over the roof slab afforded by the tile, and the protecting covering of cinders (which at the same time forms the roof slopes) to keep the temperature of the air in the dead air space at the normal temperature, allow little chance of condensation except when the ventilation is insufficient. The principal objection is the weight of this type of insulation, but where a positive insulator is required the advantages cited overcome the disadvantages of weight.

DOUBLE ROOF OF CONCRETE SLABS

A somewhat new and little used type of construction is that of a secondary concrete roof slab pitched for drainage, supported on a wooden framework resting on the concrete roof slab. The framework can be built up of 2-in. x 6-in. stringers set on edge on the slab and in turn supporting, by means of short struts and braces, 2-in. x 6-in. rafters directly above at the required height and slope.² The several frames thus formed are tied together with longitudinal and diagonal braces at such distances apart as can be spanned by the thin concrete slab to be placed on the stiffened metal lath fastened to the top of frames. The ribbed metal lath should be lapped at the sides and the ends, and securely fastened together. It will be found most economical to use the maximum span allowable for the heaviest metal lath obtainable. This is a No. 24-ga. stiffened metal lath which will support without other centering a 2-in. concrete slab before the same has set on a span of 6'. After hardening such a slab will readily carry a live load of 25 lbs. per sq. ft.

The concrete of a 1:2:4, or better still, a 1:1½:3 mixture should be mixed rather dry, for if there is an excess of water some of the cement will be carried away when the water drips through the mesh. The coarse aggregate used should be a crushed stone or gravel passing a ¾-in. mesh. The slab should be given a smooth float finish ready to receive roofing or waterproofing, which should be of the best, for if any moisture reaches the metal mesh it will soon rust and the wood supports rot out and the roof be destroyed. This construction weighs about 30 lbs. to 35 lbs. per sq. ft. and will cost on an average about 16 cts. per sq. ft.

This construction gives a continuous dead air space over the roof slab

²This method was detailed in the Feb., 1913, issue, p. 90

and if the work is well done and the ends effectively closed it provides a very effective insulation for any type of building. It has the disadvantages of high first cost and the use of a wooden framework, which does not bring the construction within the fireproof classification.

SUSPENDED CEILINGS

Suspended ceilings are used quite frequently to prevent heat radiation and condensation on concrete roofs. In beam and girder construction good insulation can be obtained by fastening a metal lath to the bottoms of the beams with wires or expansion bolts and applying a cement plaster. Where the spans are short an ordinary metal lath will suffice but for long spans (over 2') a stiffened metal lath should be used. The lath should be lapped and wired together at sides and ends so as to form a stiff surface. The type of ceiling just described will cost about 6 cts. to 7 cts. per sq. ft.

For flat slab roofs without beams or girders a different type of suspended ceiling is used. This construction consists mainly of a No. 26-ga. stiffened metal lath ceiling wired at every rib to $\frac{1}{4}$ -in. x $1\frac{1}{2}$ -in. flats or $1\frac{1}{4}$ -in. channels 5' o. c., running at right angles to the ribs, the flats or channels being supported by No. 7 wire hangers or by $\frac{1}{4}$ -in. x 1-in. flats spaced about 5' o. c. hung from the concrete roof slab and placed at the time of pouring the latter. If a lighter or No. 24-ga. stiffened metal lath is used, the supports should be not more than 4' o. c. Such a ceiling will cost on an average $10\frac{1}{2}$ cts. per sq. ft.

These ceilings should be plastered with a 1:5:12 plaster consisting of hydrated lime, Portland cement and sand, respectively, thoroughly mixed while dry before adding water. Long cow-hair should be used in the plaster.

On account of the dead air space between roof and ceiling this type of construction gives a very positive insulation. The metal lath, however, has a tendency to rust and experience has shown that suspended ceilings will break down in hot fires. Then again the roof slab must be sloped or other provision made for drainage, which adds to the cost. Suspended ceilings have been used as insulators in nearly every class of buildings including power houses, mills and roundhouses and have in general given good service.

CONCLUSIONS

From the above it will be seen that roofing felts and quilts can be

used only on roof slabs of buildings that are unheated. Cinder fills form good insulators as well as providing for drainage, while cinder concrete fills are too heavy to use in most cases and are otherwise unsatisfactory. The hollow tile insulation for sloped roofs gives excellent results, while if all things are taken into consideration the combination hollow tile and cinder fill insulation fulfills all the requirements of a positive insulation. It is twice as heavy as the double concrete roof construction and five times as heavy as a suspended ceiling and consequently requires a heavier and stronger roof construction. This will, however, in a measure be offset by the cost of the extra story height required, due to sloping roof where a suspended ceiling is used, if the same clear story height is required in both cases.

In selecting a type of insulation for a concrete roof slab a very careful study should be made of all conditions and factors entering into the particular case at hand and it is therefore difficult to lay down any hard and fast rules as to what type to use for each class of structure. Individual judgment and the past experience of others are always important factors in any selection.

Repairing Unsatisfactory Stucco

DISCUSSED BY C. W. BOYNTON¹

"I have applied a cement stucco finish to the exterior of a building, which shows marked irregularities in color, due, I believe, to using the mixture too rich. A 1:2 mix sand and cement was applied in rather hot weather.

"Each day's work is distinctive now. Since I intend to remedy this under any circumstances, could you give me any suggestions as to the simplest method to follow? Would a solution of muriatic acid sprayed on in a fine mist produce any uniformity? Would you advise putting on an additional light coat of the proper cement mixture?"

BY MR. BOYNTON

There are several methods which may be used to improve the appearance of a cement stucco surface which, due to the method employed in construction, is not uniform in appearance. Probably the cheapest and most satisfactory method of improving the appearance of rough-

cast stucco would be to apply a concrete paint with some sort of a spraying machine. By this method the surface could easily be given a satisfactory appearance. The paint used should be one which is manufactured especially for concrete work, as others will be apt to fade and prove unsatisfactory. Another method that may be used is to apply another stucco coat to the surface of the walls, but this method will probably be more expensive than the first mentioned. If another stucco coat is applied, the surface of the walls should be thoroughly wet before the new plaster coat is placed.

The Pressure Required in Compacting Concrete

DISCUSSED BY J. K. HARRIDGE²

"Of the three methods used to obtain density in the manipulation of the concrete in block manufacture: pouring a wet mixture, tamping, or the application of pressure, I should like to see some discussion of pressure. How much pressure is required properly to compact concrete in a mold box?"

BY MR. HARRIDGE

The discussion of pressure so applied to "wet concrete" can hardly be approached from any definite grounds. There are many elements which enter into results and the requirements to reach certain results, among them being:

Thickness of face or bulk of concrete to be pressed:

Size of largest aggregate used:

Degree of fineness of sand:

Grading of intermediate aggregate.

The amount of water in the mixture.

There is much difference of opinion among block makers and others as to what constitutes a wet mixture. In talking wet mixture we mean what is usually known as "quaky."

There is no value whatever to be attached to any pressure above what is actually required to eliminate from the concrete mass the excess water (or the water which fills what would otherwise be voids in the mixture before submitting to pressure) and to break down any arches which may be set up by the large aggregate and to dense the material so that the block can immediately be handled or released from the mold and set aside for curing. The intent of

¹Engr. in Chg. Information Bur., Universal Portland Cement Co., Chicago

²Barron & Harridge, Insurance Exch. Bldg., Chicago

course is that the resulting product shall have a properly low absorption. A given amount of wet concrete can be compressed a certain amount only, regardless of the extent of pressure applied.

With machinery built to apply from 75,000 lbs. to 150,000 lbs. pressure and the pressure head adjustable for varying thicknesses of block, quality of aggregate, etc., it is for the manufacturer of block to apply whatever pressure may be needed for proper results and this is determined by the conditions present. There is no rule for figuring the amount of pressure.

The Use of Pneumatic Tampers in Products Manufacture

DISCUSSED BY CHARLES E. SIMS¹

"I should like some information as to the use of pneumatic tampers in products manufacture, particularly in making pipe."

By MR. SIMS

The use of air tampers in making concrete pipe is not to be strongly recommended. Where it has been tried out it has been found difficult to get men to hold the machine on account of the vibration, which taxes the endurance greatly. The effectiveness of the blows is limited to the pressure put upon the tamper handle by the operator, hence the concrete

is not uniformly tamped. Such a system comes under the class of hand work. A man without the air tamper can use the old fashioned tamper on the end of a wooden handle or a steel rod as effectively and at the same rate of production. I do not doubt that some parts might be packed more densely by the air tamper but there would doubtless be parts imperfectly tamped by this method. I should prefer a system giving a uniformly dense product to one giving a patchy product. This statement leads to the use of a power machine, but if the amount of pipe to be made is not enough to warrant this kind of equipment and plant, I scarcely think it would add much to hand methods to install an air tamping outfit.

Air tamping was tried at Armstrong and at Sae City, Ia., among other places. Poured concrete is another makeshift, incomparable to machine-tamped concrete.

Concrete Pavement Surface on Grades

DISCUSSED BY C. W. BOYNTON

"We purpose putting in concrete pavements on some streets where there are grades exceeding 5%. What is the best treatment for the surface of the concrete on such grades with reference to foothold and to wearing qualities?"

By MR. BOYNTON

Many plans have been tried for providing a sure foothold for horses

on concrete pavements, corrugating, brooming, blocking the surface into squares and rectangles and others too numerous to mention. To a very large extent such treatments are entirely unnecessary and can well be dispensed with.

Clark R. Mandigo, asst. city engr. of Kansas City, in an article descriptive of the pavements of that city, which appears in *Engineering News*, July 17, 1913, makes this statement in regard to concrete pavement:

It is never slippery in any kind of weather, and has been laid on grades as high as 18%. It is of low tractive resistance and offers an excellent foothold for horses.

At Davenport, Ia., where a strip of concrete was placed between two strips of brick pavement on a grade of from 9½% to 12%, it has been noticed that teamsters generally prefer to drive on the concrete center strip, rather than on the brick sides.

Carl C. Widener, city engr., Bozeman, Mont., discussing in *Rock Products*, June 22, 1912, the possible changes in the specifications for concrete pavements in that city, said that where the street was very steep, he would allow marking though he did not regard concrete as slippery and would hesitate before allowing it to be marked at all.

Corrugating a concrete pavement is objectionable because it not only adds to the cost without improving the foothold, but also hastens wear due to the impact on the depressions. What is commonly termed a wood float finish is of sufficient roughness for concrete pavements. Laid on grades not exceeding 10%. Any pavement will be slippery, however, when covered with sleet, whatever the type or the treatment.

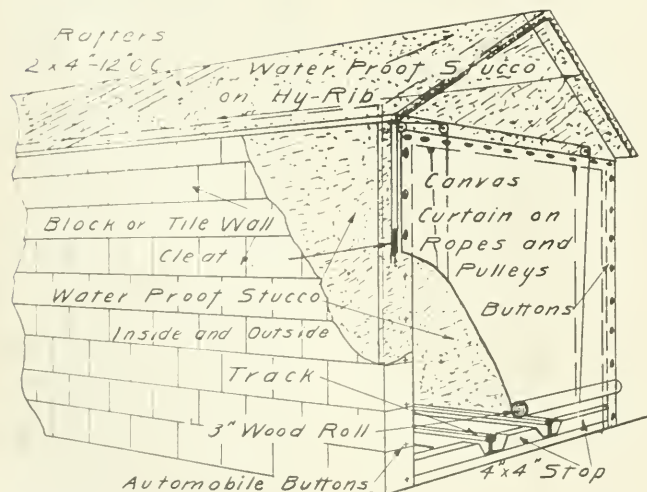
Treating Canvas Curtains for Steam Rooms

DISCUSSED BY S. H. WIGHTMAN¹ AND JOHN SHIPLEY²

"With what preparation shall I treat canvas doors used at the ends of steam curing chambers, so that the doors will keep the steam in and at the same time remain sufficiently pliable to roll up easily?"

By MR. WIGHTMAN

The best preparation to waterproof canvas roll doors and at the same time not stiffen the canvas, which would interfere with the rolling and cause cutting at points where the cords came in contact with it,



SKETCH OF DOOR CONSTRUCTION FOR STEAM ROOM

¹Concrete Products Engr. Co., Detroit

²Supt., Gandy Belting Co., Baltimore

undoubtedly is Preservo. This can be obtained in colors (brown is best) at about \$1.25 per single gal., \$1.00 in 5-gal. lots, 55 cts. in bbl. lots. Ship chandlers usually carry this material.

The roll type of door is often the most suitable. Never oil canvas, as this tends to rot it. Paraffining canvas takes the life out of it, and it shrinks more when put to service. A double or triple filled canvas, No. 10, which is about a 12-oz. cloth, will give the best service. It can be obtained in any width up to 10' for about $4\frac{1}{2}$ cts. per sq. ft.

A 3-in. wood roll should be used

at the bottom, to prevent puckering. A 4-in. x 4-in. timber can be placed at the floor line between rails to form a stop. On the sides, automobile curtain buttons can be used after shrinkage has taken place.

BY MR. SHIPLEY

I agree with Mr. Cline³ that boiled linseed oil is the best treatment for canvas, for doors of steam rooms. According to my recollection the sailors treat all of their waterproof clothing with pure boiled linseed oil. I do not know but that steam will even take the boiled linseed oil out of single canvas.

eering practice have furnished us with data so to design the structure that we meet and overcome the forces of Nature with a greater or less degree of safety, depending very much on how well the architect or designing engineers and the builder understand their business and the material desired to be used for the purpose. An additional obstacle is frequently met in that the owner of the proposed structure is not able or does not desire to invest enough money in the work to secure a first class job, and thereupon may hinge the whole key to the situation as to why some supposedly good work has failed to deliver the goods.

Why Should Silos Be Round?

DISCUSSED BY JOHN H. MCCOY¹

"Silos, grain bins, water tanks, etc., are all cylinders. Why couldn't these structures be hexagonal in plan? Wouldn't it be easier to handle the forms, and wouldn't an hexagonal one be just as efficient structurally?"

BY MR. MCCOY

Silos are preferably built round because there is less wall surface for a given cu. ft. content than in any other shape the structure might be built. For example, a silo 16' inside diameter contains 201.06 cu. ft. per ft. elevation and the circumference is $50' 3\frac{3}{16}"$. For the same capacity in an hexagonal silo, the distance around is $52' 9"$ and the six sides each have a length of $8' 9\frac{1}{2}"$. For a square silo containing the same number of cu. ft., the lengths of its four sides would be $56' 8\frac{5}{8}"$ or $14' 2\frac{1}{4}"$ each. The above figures prove that the circular structures give the greatest amount of capacity for the smallest amount of building material. For the purpose of silos, water tanks and grain elevators, it is very much more expensive to build using any other shape than circular, because of the lateral stresses exerted on the sides by the contents. It is necessary for the successful builder to know before he begins his work that the design and materials, if properly worked out and assembled, will safely do the work required of them. Thus it is necessary to know just what the pressure exerted upon the structure by the contents thereof shall definitely be at any and every point.

To secure the necessary strength

in an hexagonal or any other shaped structure except the circular, the side walls are unevenly stressed, and consequently it is necessary to use a great deal more material to secure the proper resistance than is required where the structure is uniformly stressed at every point all the way round its interior surface at any given elevation.

Another point not previously referred to is that a silo with four or more sides, these sides coming together with lines more or less at right angles, not only develops a greater wall surface friction in the settling of the silage, but thereby to that extent, prevents the silage from packing as it otherwise would do. This, of course, reduces the capacity of the silo. In addition to these faults, the silage does not pack nor can it be so tightly packed in the more or less abrupt angles of the wall. In the circular silo, however, in which the wall friction is alike at all points, and reduced to a minimum, the silage packs and settles evenly and tightly, thereby securing the owner the best possible silage and the greatest feeding capacity for the lowest possible dollar of original cost for the structure when made of the best material for the purpose. The circular concrete wall form is a marketable proposition, because these forms can be used over and over and are much cheaper and more efficient than the straightway wall forms built of either steel or lumber. This has been demonstrated many times by contractors and other builders in this class of construction work.

When the structure is built circular and plumb, science and safe engin-

Required Thickness for Concrete Roofs

DISCUSSED BY IRA H. WOOLSON¹

"What is the average (general) requirement of the building departments of the prominent American cities as to the thickness of concrete slab roofings, both reinforced, and otherwise? Any information you can give us along this line will be greatly appreciated."

BY MR. WOOLSON

In regard to the thickness of reinforced concrete roof slabs, I have had the most recent codes of 25 prominent cities examined, and have found only eight which specifically mention a minimum thickness. Of these, seven give 3" as the minimum, and one, New York, requires $3\frac{1}{2}"$ as the minimum. Chicago and one or two other cities require a thickness of $1\frac{1}{2}"$ per ft. of span. I think, therefore, that it can be assumed with a fair degree of safety that the average requirement of building departments in prominent cities is 3". Personally I advocate a minimum of $3\frac{1}{2}"$ for a general specification. Of course this might be modified for special conditions or construction.

I do not think that segmental arches are at all common for roof construction. Such arches would require at least a minimum thickness of 3" at the crown, but this method of construction is rather heavy for roofs, and not so easy to install.

Vigilance and watchfulness insure safety.

¹Pres., McCoy Silo Form Co., Inc., Pittsburgh

³A. E. Cline, in Mar., 1914, issue, p. 131

²Cons. Engrs., Natl. Board of Fire Underwriters, N. Y. C.

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

The Economic Design of Concrete "T" Beams

A LETTER FROM W. E. WAGNER¹

The following is a simplified analysis of the "T" beam, in which the neutral axis falls below the bottom of the flange.

The amount of reinforcement and the depth of the neutral axis are taken in terms of the area of the flange, and its thickness, respectively, i. e., in terms of effective concrete in compression.

From the resultant equations it is possible, with a given thickness of flange, to obtain at once the economic depth of beam, for varying percentages of reinforcement, or vice versa.

Curves have been plotted, showing the depth of the neutral axis when both concrete and steel are stressed to their full values, for different unit stresses that are likely to occur in practice; also to show the economic relation the depth of beam holds to the thickness of flange, for different percentages of reinforcement. The full lines are for stresses and value of n recommended by the Joint committee, as published in the transactions of the Am. Soc. of Civ. Engrs. for Mar., 1910.

The general assumptions made in the following equations are the same as are used for all straight-line formulas, and the compression in the stem of the beam is neglected.

f_s —unit tensile stress in steel
 f_c —unit comp. stress in extreme fibre of concrete
 n — E_s modulus of elasticity of steel
 E_c —modulus of elasticity of concrete

M —moment of resistance or bending moment

A —area of steel

b —breadth of flange

d —depth to center of steel

k —ratio of depth of neutral axis to thickness of flange

t —thickness of flange

p —ratio of steel to area of flange $A \div bt$

Stress at top of flange= f_c

Stress at bottom of flange=

$$\frac{f_c}{n}(nt + t) = f_c - \frac{f_c}{n}$$

Average stress in flange=

$$f_c \left(1 - \frac{1}{2n}\right)$$

(1) Total comp. stress=

$$b t f_c \left(1 - \frac{1}{2n}\right)$$

(2) Total tensile stress=

$$A f_s = f_s b t p$$

Equating (1) to (2)

$$f_s p = f_c \left(1 - \frac{1}{2n}\right) \quad (3)$$

$$k = \frac{f_c}{2(f_c - f_s p)} \quad (4)$$

Note—From the equation (4) it is seen that the neutral axis falls below the bottom of the flange when p is equal to or greater than $f_c \div f_s$, provided, of course, that concrete and steel are fully stressed.

The neutral axis is at infinity, that is, the stress in the flange is uniform when $p = f_c \div f_s$. Thus it is seen that the variation in the amount of reinforcement, for economical design within working limits, must be small.

This equation and the following equations hold only when the neutral axis falls below the flange, but they can be used for any beam if t is taken as the effective thickness, i. e., of the portion above the neutral axis, k being equal to unity.

According to assumption

$$f_s = \frac{f_c n (d - kt)}{n p} \quad (5)$$

Combining (3) and (5), so as to eliminate k ,

$$p = \frac{f_c n (2d - t) - f_s t (6)}{2 f_s n d}$$

This gives the proportion of steel required to develop the stress f_s in the steel, and f_c in extreme fibre of the flange

Combining (3) and (5)

$$n = \frac{p n d + t/2}{t(1 - p n)} \quad (7)$$

Also from (3) and (5)

$$\frac{d}{t} = \frac{f_c n + f_s}{2 n (f_c - f_s p)} \quad (8)$$

From equation 7 it is seen that the neutral axis is located at the bottom of the flange when

$$\frac{d}{t} = \frac{1}{2 p n} + 1$$

For $f_s = 16,000$, $f_c = 650$; it is found from equation 4 that $p = .0203$

Taking $n = 15$

$$\frac{d}{t} = 2.64$$

Therefore for all "T" beams having a depth 2.64 times the thickness of the flange, the neutral axis is located at the bottom of the flange, for economical design, with above stresses in steel and concrete.

See Fig. 3 for curve showing relation of t to d for different proportions of reinforcement. In Fig. 2 for lowest point of curve $k = 1$; that is, the neutral axis lies at bottom of the flange. In the top of curve, $k = 2$.

TO GET LENGTH OF LEVER ARM

Uniform stress on rectangle

$$1234 = f_c \cdot \frac{f_s}{n}$$

Average stress on triangle

$$345 = \frac{1}{2} \{ f_c - (f_c - \frac{f_s}{n}) \} = \frac{f_c}{2n}$$

Total stress on

$$1234 = b t f_c \left(1 - \frac{1}{n}\right)$$

and acts at distance $l/2$ from top of flange.

¹Engr. and Contr., Toronto, Ont.

Total stress on

$$34.5 = bt \frac{f_c}{2n}$$

and acts at distance $t/3$ from top of flange.

But

$$\frac{a}{a'} = \frac{bt \frac{f_c}{2n}}{bt f_s (1 - \frac{1}{n})} = \frac{1}{2n-2} \quad (9)$$

Combining (9) and (10)

$$a + a' = \frac{t}{6} \quad \therefore a' = \frac{t}{6} - a \quad (10)$$

$$a = \frac{t}{6(2n-1)}$$

Length of lever arm=

$$d - \frac{t(3n-2)}{6(n-3)} \quad (11)$$

Moment of steel about center of compression=

$$A f_s (d - \frac{t(3n-2)}{6(n-3)}) \quad (12)$$

Moment of concrete about center of steel=

$$bt f_c (\frac{1-t}{2n}) (d - \frac{t(3n-2)}{6(n-3)}) \quad (13)$$

Moment of inertia of flange about neutral axis=

$$\frac{bt^3}{12} + bt (n - \frac{t}{2})^2 = bt^3 (n^2 - n + \frac{1}{3})$$

Moment of concrete about neutral axis=

$$\frac{bt^3 f_c}{n} (n^2 - n + \frac{1}{3}) \quad (14)$$

Moment of steel about neutral axis=

$$M_A = A f_s (d - nt) = p b t f_s (d - nt)$$

Moment of beam=

$$M_c + M_s = \frac{bt^2 f_c}{n} (n^2 - n + \frac{1}{3}) + p b t f_s (d - nt) \quad (16)$$

Combining (5) and (16)

$$M = \frac{b f_c}{n} \left\{ n^2 t^2 - nt^2 + \frac{t^3}{3} + p n (d - nt)^2 \right\} \quad (17)$$

This gives the moment of resistance of the beam with the strength of the concrete as the limiting factor. From (5) and (16)

$$M = \frac{b f_s t}{n(d - nt)} \left\{ n^2 t^2 - nt^2 + \frac{t^3}{3} + p n (d - nt)^2 \right\} \quad (18)$$

This gives the moment of resistance of the beam with the strength of the steel as the limiting factor.

Note—For beams with the neutral axis above the bottom of the flange, and calling for effective thickness of the flange, that is, the portion above the neutral axis t , the relation of t to d is same as t' to d .

In this case $K=1$, and from (7)

$$t' = \frac{An + \sqrt{A^2 n^2 + 2Anbd}}{b}$$

p must be expressed in terms of bt' .

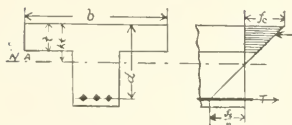


Fig. 1

depth of the beam is chosen to suit the span and head room.

Given a floor slab 6" thick, and choosing the depth of beam as 20" to find the area of steel required for a bending moment of 2,150,000 in lbs.

The center of compression of the concrete cannot fall below the cen-

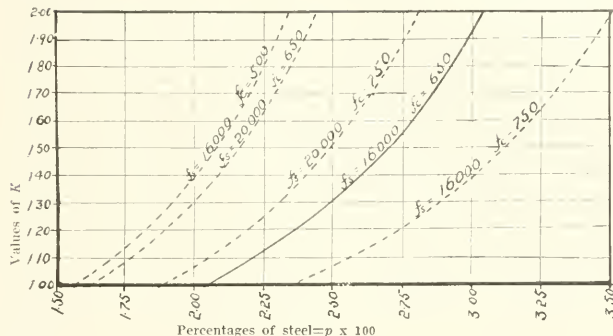


Fig. 2

METHOD OF CALCULATION

Taking $f_s=16,000$ $f_c=650$ $n=15$

For a beam with an effective depth of 24", and thickness of flange 6", what is the economical area of steel, and moment of resistance of the beam?

Taking the stem at 12" $b=60''$

$$\frac{d}{t} = \frac{24}{6} = 4$$

From Fig. 3 the economical percentage of steel is found to be 2.72,

ter of the flange. That is the distance between the center of compression and the center of tension cannot, in this case, be less than 17".

Approximately—By taking moments about the center of compression

$$A = \frac{2,150,000}{17 \times 16000} = 7.92 \text{ sq in}$$

$d/t=3.33$ and from Fig. 3 it is seen that the economical percentage of steel is 2.45.

Taking the width of stem as 12". b will equal 60" and bt 360 sq. ins.

7.92 sq. in. is 2.2% of bt , and since this is less than the economical percentage of steel for the beam, the concrete can be depended on to develop the strength of the steel, without further investigation. Had the percentage of steel found been greater than the economical percentage, the depth of the beam would have to be increased. As an alternative, steel could be added to resist compression, but this is very uneconomical.

Having found the approximate area of steel, and that the proportions of the beam are suitable for the load, proceed now to calculate the exact area of steel required.

From equation (7)

$$M = \frac{.022 \times 15 \times 20 \times 6/2}{6(1 + .022 \times 15)} = 120$$

From equation (12) $A=7.58$.

The greatest loss of compressive resistance, due to neglecting the compression in the stem, for all proportions of d to t given in Fig. 3 will

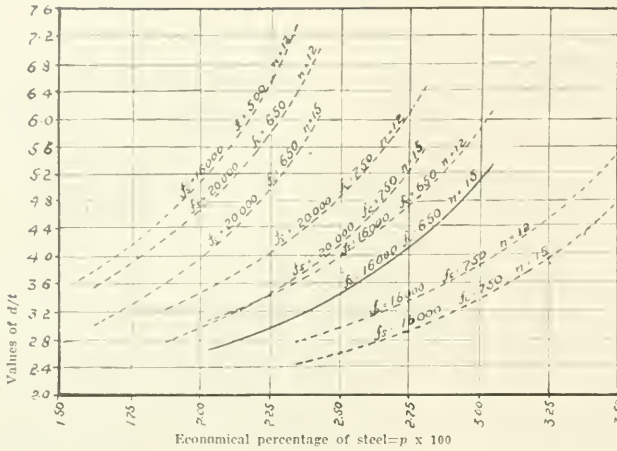


FIG. 3

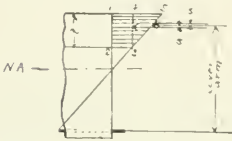


FIG. 4

not exceed 7% or 8%. In case $d \div t$ lies above the curve marked on the figure, allowance should be made for the compressive resistance of the stem, and if it lies below the curve, the neutral lies within the flange, and the beam must be calculated as a simple beam.

Where the holes were made, it hardened in 24 hrs. and after three weeks drills were sunk into the center of the two piers and it was learned that they had become hard and sound. The bridge is today a satisfactory structure in every respect. It is evident, however, that in cool weather concrete may remain practically inert for months, become frozen as this did, and on finally thawing out obtain its full strength and stability.

These piers were saved by the fact that the outer 2" or 3" which contained reinforcement in both faces had set in the moderate weather just after they were poured, but it is just as evident that the interior had not set before cold weather arrived.

In Mr. Neal's case, the concrete in the interior of his girders had probably not even taken its initial set.

LIGHT SECTIONS MAKE FOR QUICK HARDENING

While not exactly of the same character, another instance came to the writer's attention which showed the value of a reinforced concrete wall as compared to a gravity wall of the same height.

The writer had occasion to construct an arch bridge having extended spandrel walls or retaining walls 20' or 30' long and about 16' high. These were very thin and had reinforcement on the inner faces. A short distance away from the bridge the city had a contractor build a gravity wall of the same height, which was constructed on ledge rock. Both walls were poured on the same day and four days thereafter a very heavy rain filled the entire space back of each wall with water. The gravity wall, which was 8' thick at the bottom, collapsed and was entirely destroyed, and an examination of the material immediately thereafter showed that the interior had not become hard. The reinforced concrete wall, which was 12" thick at the top and 2' 6" thick at its greatest dimension, stood the same pressure with no apparent distress. It was evident that in the latter case not only had the thin wall had a greater opportunity to become hard, but the portion of it which surrounded the wall on the tension side adhered strongly enough to the steel to withstand the pressure.

When you finish a job, leave conditions safe. Replace safeguards, and do not leave loose material overhead where it may fall.

Movements and Stresses in Green Concrete

A LETTER FROM WALTER M. DENMAN¹

The writer has noted with some interest the experience² of Charles H. Neal, Asheville, N. C., in jacking up the reinforced concrete bridge which sagged when the supports under the forms were washed out. The probability is that the solution of the mystery as to why the concrete became sound is in the simple fact that it had not set except upon the surface.

According to his statement, he was pouring the concrete when the rain came on, and doubtless the atmosphere contained a high degree of humidity to begin with, and the rain thoroughly wet his concrete, so that the set was materially delayed. It is probable that a certain amount of the adhesion of the concrete to the bars at the bottoms of the girders was destroyed but not sufficiently entirely to eliminate their functions.

DELAY IN THE SET OF BRIDGE PIERS

The writer had a case several years ago in which an arch bridge built in six spans of 28' to 40' had the piers and arch rings constructed in November, and after two or three weeks the forms were removed from some of the piers and they were surfaced. The following spring when the weather became quite warm it was noticed that near the base of the piers the surface began to flake off to a depth of 1" or so. This occurrence was not similar to that of frozen concrete but evidently due to compression as the surface would bulge before flaking off. A hole was dug into the worst pier and it was found that at a depth of from 3" to 5" the concrete had not set but was still in a moist condition. Shoring and jacks were placed under the haunches of the adjoining arches and left there for several weeks, while the action of the concrete in the interior of the two worst piers was carefully watched.

¹Design. and Consult. Engr., Springfield, Mass.

²Noted on p. 83, Feb., 1911, issue

Current Prices, Concrete Materials

Portland Cement—The cement market has advanced very little in the last month, but the prospects are very good for an increase of activities in all lines. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, \$1.72; N. Y. C., \$1.58; Chicago, \$1.55; Pittsburgh, \$1.50; New Orleans, \$1.64 on dock; Memphis, \$1.82; Cleveland, \$1.63; Detroit, \$1.59; Indianapolis, \$1.60; Toledo, \$1.59; St. Louis, \$1.55; Milwaukee, \$1.55; Minneapolis, and St. Paul, \$1.65 to \$1.70; Montreal, \$1.75 to \$1.80; Toronto, \$1.95; Winnipeg, \$2.40 to \$2.50; Kansas City, \$1.63; Omaha, \$1.78; Portland, Ore., \$2.10; Spokane, \$2.20; Seattle, \$2.00; Tacoma, \$1.90; Duluth, \$1.75.

Crushed Stone—1½-in. stone, prices per cu. yd., f. o. b. cars in carload lots, unless otherwise specified. Boston, 80 cts. per ton at the quarry; N. Y. C., 95 cts. to \$1.00, in full cargo lots at the docks; Chicago, \$1.15; Toronto, 75 cts. per ton at quarries; Spokane, \$1.25; Seattle, \$1.25; Portland, Ore., \$1.00; Tacoma, \$1.25.

Gravel—Prices given are per cu. yd. f. o. b. cars in carload lots unless otherwise noted. Boston, 75 cts.; N. Y. C., 95 cts. to \$1.00, in full cargo lots at docks; Chicago, \$1.15; Portland, Ore., 85 cts.; Spokane, \$1.50; Seattle, 75 cts.; Winnipeg, \$1.85; Tacoma, 60 cts.

Sand—Prices are per cu. yd., f. o. b. cars in carload lots unless otherwise indicated. N. Y. C., 50 cts., full cargo lots at docks; Chicago, \$1.15; Toronto, \$1.15; Portland, Ore., 85 cts.; Spokane, \$1.25; Seattle, 75 cts.; Winnipeg, \$1.75; Tacoma, 60 cts.

Reinforcing Bars—The demand is increasing, but the prices in general are about the same as last month. Pittsburgh base quotations on mill shipments f. o. b. cars, are from \$1.20 per cwt., with the prevailing extras on bars under ¾-in. or base. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: N. Y. C., \$1.31; Philadelphia, \$1.35; Chicago, \$1.38; Portland, Ore., \$1.25; Spokane, \$2.25; Seattle, \$2.15; Tacoma, \$1.90.

Shipments from stock are being made at the following prices per cwt. f. o. b. cars: Pittsburgh, \$1.70; N. Y. C., \$1.90; Cleveland, \$1.75; Cincinnati, \$1.75; Chicago, \$1.85; Montreal, \$2.15; Toronto, \$2.25; Winnipeg, \$2.50; Portland, Ore., \$2.10; Spokane, \$2.55; Tacoma, \$2.05; Seattle, \$2.15.

Metal Clips for Supporting Bars—\$7.25 to \$8.00 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh

Organizations

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa.

American Highway Association, J. E. Pennybacker, Jr., Secretary, Colorado Bldg., Washington, D. C. Convention, Atlanta, Ga., Nov. 9-14.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention, Chicago, December. (Definite dates to be announced later.)

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co., 72 West Adams St., Chicago, Ill.; J. P. Beck, Sec.

Interstate Cement Tile Manufacturers' Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. B. Beck, Sec., 72 W. Adams St., Chicago.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

quotation given, the price of bars at any of the points listed can be readily computed.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	.....	16	cts.
New York	.....	16	"
Philadelphia	.....	15	"
Baltimore	.....	14½	"
Boston	.....	18	"
Buffalo	.....	11	"
Norfolk	.....	20	"
Cleveland	.....	10	"
Birmingham	.....	45	"
Columbus	.....	12	"
Cincinnati	.....	15	"
Louisville	.....	18	"
Chicago	.....	18	"
Richmond	.....	20	"
Denver	.....	81½	"
St. Louis	.....	22½	"
New Orleans	.....	30	"

Architectural Concrete Units in House in Turkey

This house with its rather elaborate treatment in concrete units is in Trebizond, Turkey. It forms an interesting contrast with the house, a portion of which is shown at the left, with its rough plastered walls, which are probably of stone and its disintegrating tile roof. The architectural concrete units were manufactured by Velissarides & Co. from molds supplied by the Simpson Cement Mold Co., Columbus, O. The special units include columns, round and square balusters, window caps and ball finials.



HOUSE IN TREBIZOND, TURKEY

Tests on Plain and Reinforced Concrete Tiles¹

By GEORGE P. DIEKMANN²

In presenting the results of the tests made on plain and reinforced concrete tile, I wish to state that these tests are only the beginning of a more exhaustive investigation to be carried out along this line. I am sure that the obtained results of the tests are of sufficient interest to warrant their presentation.

These tests were started at P. H. Atwood's³ suggestion and were carried out at the Armstrong Cement Tile Co.'s plant. The testing of the tile was done with the assistance of the engineering department at Ames, Ia., and witnessed by Prof. A. Marston, Prof. Stewart and Mr. Atwood, who are members of Committee 6 on Specifications of Drain Tile of the Am. Soc. for Test. Mat. There were also a great number of engineers present when the tests were made.

The material used was Northwestern States Portland cement, tested according to standard specifications, with the following results:

Fineness—100-mesh sieve, 95.2. 200-mesh, 76.8
Setting—Initial: 3 hr. 20 min.
Final: 6 hr. 20 min.
Soundness—Perfect.

TENSILE STRENGTH IN LBS. PER SQ. IN.

	Neat	1:3
24 hrs.	310 lbs.	
7 das.	690 lbs.	250 lbs.
28 das.	740 lbs.	300 lbs.
60 das.	765 lbs.	330 lbs.

The sand was sharp and clean and had the following granular composition:

CHEMICAL ANALYSIS

Silica	21.00%
Alumina	7.36%
Oxide of Iron	3.18%
Lime	62.70%
Magnesia	1.70%
Sulphuric Acid	.71%
Passed on 100-mesh sieve	3.5%
Passed on 50-mesh sieve	11.5%
Passed on 30-mesh sieve	25%
Passed on 20-mesh sieve	20%
Passed on 10-mesh sieve	23%

Retained on 10-mesh sieve	17%
Total	100%

The wire for the reinforcing was the double wire hoop No. 7 wire, 0.176" in diameter. The mixture employed consisted of 1 part cement and 3 parts sand. The semi-wet mixture was used; the materials mixed dry in the batch mixer and then wetted in a continuous mixer. Care was taken to mix the mortar as uniformly as practically possible. The tile was made on a Quinn' tile machine, power tamped, and cured for

18 hrs. in steam, and for the remainder of the time cured in air until tested (see table), with the exception of Nos. 4, 5 and 6, marked W-0. These tile were wetted about 27, 29 and 52 hrs. respectively before breaking. Then all the tile were tested according to the Iowa standard method on the Ames tile machine.

All the tests were made on 28-in. tile with 1/10 wall thickness.

In the table it will be noted that there were seven different series of tile, each series having three tiles. Numbers one to six are plain concrete tile and marked D-0 and W-0. The wire hoops were embedded 1 1/2" from outside and 1 1/2" from inner wall (note further details as to placing, in table).

Serial R-2 has two reinforcing double wire hoops.

Serial R-3 has three reinforcing double wire hoops.

Serial R-4 has four reinforcing double wire hoops.

Serial R-5 has five reinforcing double wire hoops.

Serial R-6 has six reinforcing double wire hoops.

In looking over the obtained results you will note that the weights and measurements of the tested tile are very uniform throughout. Also the obtained results can be considered uniform.

The tile Nos. 4, 5 and 6 show a lower breaking strength than the tile Nos. 1, 2 and 3 tested dry.

The first checking of the tile under the load, results which you will find in the upper figures, will practically average 6,050 lbs. whether the tile is plain or reinforced.

The type R-2 with two wire hoops collapsed with the exception of tile No. 9, like the plain tile.

TESTS OF ARMSTRONG 28-IN CEMENT TILE

Vertical	Type	No. of Double Hoops	Internal Dia., Ins.		Ave. Thickness of Wall—Ins.		Length—Ins.	Weight—Lbs.	Lbs. Breaking Loads			Strength Added by reinforcing %	Placing of Wire Hoops
			Vertical	Horizontal	Top	Bottom			Applied	Total	Per Ft.		
1	D-0	0	28.0	28.1	2.70	2.72	29.8	617	6,390	6,790	2,730		
2	D-0	0	28.2	27.9	2.72	2.75	29.8	618	5,820	6,220	2,500		None
3	D-0	0	28.5	28.1	2.75	2.75	30.0	640	7,270	7,670	3,070		None
Average									6,490	6,890	2,770		None
4	W-0	0	28.2	28.1	2.60	2.65	29.9	645	4,470	4,870	1,950		None
5	W-0	0	28.0	27.8	2.62	2.75	30.0	650	5,150	5,550	2,220		None
6	W-0	0	28.4	28.2	2.62	2.82	29.7	650	5,310	5,710	2,300		None
Average									4,980	5,380	2,160		None
7	R-2	2	28.2	28.2	2.65	2.82	29.9	630	6,360	6,860	2,760	00.010"	from top
8	R-2	2	28.0	28.1	2.78	2.78	29.9	640	5,820	6,220	2,500	16.115"	from bottom
9	R-2	2	28.1	27.8	2.72	2.72	30.0	628	6,460	6,860	2,740	00.0	
Average									5,220	5,620	2,250	00.0	
10	R-3	3	27.9	28.1	2.72	2.75	29.9	616	6,246	6,646	2,670	00.0	25" from top
11	R-3	3	28.2	28.6	2.57	2.78	29.9	618	5,480	5,880	2,360	16.115"	center
12	R-3	3	27.9	27.8	2.57	2.78	30.0	623	6,430	6,830	2,740	31.2	5" from bottom
Average									5,120	5,520	2,210		
13	R-4	4	28.2	28.1	2.57	2.87	29.8	625	6,820	7,220	2,900		
14	R-4	4	27.9	27.9	2.68	2.78	29.8	623	5,820	6,220	2,500		
15	R-4	4	28.0	28.2	2.60	2.85	29.9	631	5,820	6,220	2,500		
Average									9,030	10,350	4,150	51.5	
16	R-5	5	27.9	28.0	2.65	2.72	29.9	629	6,206	6,606	2,660	46.2	
17	R-5	5	28.1	27.8	2.78	2.78	29.8	627	5,790	6,190	2,490		From top
18	R-5	5	28.0	28.0	2.72	2.75	29.9	630	11,370	11,770	4,750	90.0	27"
Average									6,370	6,770	2,730	9"	
19	R-6	6	28.3	28.0	2.53	2.75	30.0	625	12,100	12,500	5,030	81.3	15"
20	R-6	6	28.0	27.7	2.62	2.78	30.0	617	5,930	6,330	2,580	9"	
21	R-6	6	28.1	27.2	2.72	2.72	29.9	632	6,030	6,430	2,500	90.3	3"
Average									11,820	12,220	4,910		
22	R-6	6	28.0	28.1	2.72	2.72	29.9	632	11,763	12,163	4,890	88.0	
Average									5,840	6,240	2,500		From top
23	R-6	6	28.0	27.7	2.62	2.78	30.0	617	11,870	12,270	4,910	96.5	27.5"
24	R-6	6	28.0	28.1	2.72	2.72	29.9	632	5,900	6,300	2,520	22.5"	
Average									12,520	12,920	5,170	105.0	17.5"
25	R-6	6	28.0	28.1	2.72	2.72	29.9	632	6,170	6,570	2,640		12.5"
Average									12,070	13,370	5,370	103.1	7.5"
26	R-6	6	28.0	28.1	2.72	2.72	29.9	632	5,970	6,370	2,550		2.5"
Average									12,133	12,533	5,153	102.0	

All above tile two months old.

Upper figures in each space refer to checking loads; lower figures to loads at which reinforcing failed.

¹Presented at convention of Interstate Cement Tile Mfrs. Assn.

²Chief chemist, Northwestern States Portland Cement Co., Mason City, Ia.

³Pres., Interstate Cement Tile Mfrs. Assn.

⁴Quinn Wire and Iron Wks., Boone, Ia.

Type R-3 with three wire hoops showed an increase over the first checking of 28.4%.

Type R-4 with four wire hoops showed an increase of 46.2%.

Type R-5 with five wire hoops showed an increase of 88%.

Type R-6 with six wire hoops showed an increase of 102%.

The results show the advantages of reinforced tile against plain tile. More work will be carried on, on different size tile and different ways of reinforcing.

Pit Silos and Above-Ground Silos

Considerable comment¹ on the subject of pit silos has appeared recently in various publications, and always this type of silo has been regarded as of temporary character only. Almost without exception the pit silos described have been pits in the ground, and the walls plastered with cement mortar. Very good so far, but the builders have not gone far enough. The mortar was not reinforced, and therein lies the real reason that the pit silo is commonly regarded as a temporary structure. If the proper reinforcement is used for good cement plaster, the wall will not crack, and will withstand the earth pressure when the silo is empty.

There is no apparent reason why the pit silo should not be as successful in wet as well as in dry soils. Properly made and reinforced, it is water-tight and air-tight; will not cave in; and these is no question about its keeping the ensilage in perfect condition. The cost of the reinforcement will perhaps equal the cost of the plaster material, but it makes the silo permanent instead of a one or two season makeshift, and in turn the total cost will be only about half that of the wood stave silo, which also is but a temporary structure.

Why would not an intelligent farmer rather build a permanent pit silo, hire it built if necessary, than a temporary wood stave silo above ground at twice the original cost? Added to the original cost of a stave silo is the labor of keeping it painted and the continued care of the hoops on a wood silo absolutely necessary to prevent collapse. His pit silo will need no care. It is true that the pit silo is more difficult to feed from than the silo above ground, but this increased labor can be reduced by various means available to

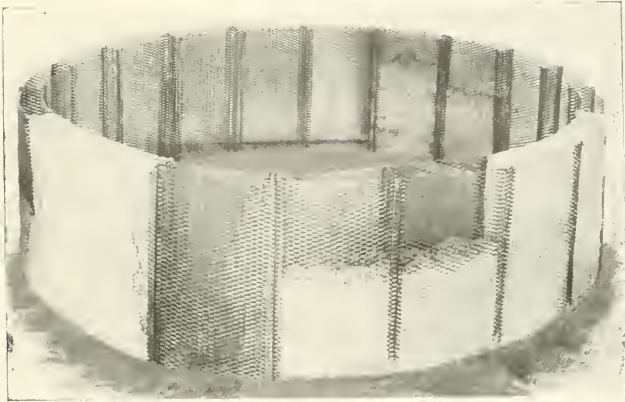


FIG. 1—COMBINATION PIT SILO AND ABOVE-GROUND SILO, REINFORCED FROM TOP TO BOTTOM

This silo was built by W. C. Myers on his farm near Burdett, Kans. Door in pit make feeding easy as from silo entirely above ground. The illustration is from a photograph taken from the feed-lot while construction was under way



FIG. 2—A CIRCULAR TANK SHOWING DIFFERENT STAGES OF CONSTRUCTION

Some of the sections at the right are partially filled with concrete and others are full. The two adjacent sections on the left have been given a partial finish coat of cement plaster

the farmer such as that rigged up by Ed. Wray, of Norton County, Kans., for his pit silos. Mr. Wray wrote an article in the issue of Aug. 22, 1913, of *Wallace's Farmer*. In this article he says:

The great bugbear of the pit silo seems to be getting the stuff out. I now have an apparatus made out of back-gearing, similar to that taken out of an old mower, with which one man can draw 40 lbs. of silage out of the bottom of a 25-ft. pit silo, and do it in 8 mins. after the silage bucket is filled. This will feed

25 head of cattle one full feed. That's fast enough, isn't it?

In the writer's opinion the only silo that is better than the properly built pit silo, is an everlasting monolithic concrete silo built right, and in a convenient place for feeding. When the farmer feels financially able to build this kind, he can use his old pit silo as a cistern, and it will make a good one.

To quote further from Mr. Wray's article:

¹See Nov., 1913, issue, p. 206, for an article on Pit Silos

The advantages of the pit silo are briefly these:

1. Small cost of construction.
2. Adaptability to the size of the herd. It costs no more to make in proportion for six head than for 600 head.
3. Can be made wherever the water is more than 25 below the surface of the ground, and the walls of a common well will stand without being bricked up.
4. Anyone can make it who can dig a cistern.
5. Small cost of machinery to fill it. When you take the elevator off of an ensilage cutter, you have not only taken off most of the cost of the machine, but you have made it possible to run it with very little horse-power.
6. It will not blow over nor rot down.
7. It will keep the ensilage perfectly. No freezing nor thawing. The temperature is the same winter and summer. Without exaggeration, after we had removed the spoiled stuff from the top, we have not found one pound of spoiled or molded ensilage.

Mr. Wray's two pit silos are each 7' x 25', and the walls were plastered with cement mortar—no reinforcement. Norton county is in a semi-arid region, and after one year's use these pit silos had not cracked, but, of course, no one familiar with cement work will give them very much longer without failure.

A PIT SILO IN A HILLSIDE

A pit silo with reinforced cement mortar walls was recently built on the farm of W. C. Myers, a farmer and stockman near Burdett, Kans. The topography of his farm is unusual in that a high bank protects his feed lot from the north winds. He started his silo at the top of this bank, making the pit 24' 6" deep, and building an extension of reinforced concrete, 5' 6" high above the top of the bank. A slit, or passageway, was cut in the bank from the silo to the feed lot, the floor of the passage being on a level with the lot and about 6' above the bottom of the pit, and open overhead. This permitted doors in the wall of the pit, next to the passage, thus cutting down labor in feeding.

Naturally all farmers haven't the convenient high bank, but no doubt many have, and probably others could move the feed lot to the bank and make money by it.

The above-ground extension of 5' 6" was built with a 5" solid concrete wall, Mr. Myers using in its erection "Lock-Form," a special expanded mesh, developing form and reinforcement.² For the pit lining reinforcement, a special mesh, "Self-

Furr,"³ was used. This method has dovetail ribs, or corrugations, stamped in the expanded metal every 8". These ribs are about 1½" deep, and of course are of the same mesh as the lath itself, being a part of it. The lath was applied with the rib side next the dirt wall, so that the plaster got a perfect key. The half inch of mortar behind the expanded metal reinforcement thoroughly embedded it. The mortar is of even thickness over the whole wall, the dovetail corrugations permitting the plaster to key along their entire length. The sheets of this material interlock at sides and ends, so that the reinforcement is continuous in every direction. The mesh was fastened to the wall by long homemade wire staples driven into the earth. The mistake should not be made of furring a plain metal lath away from the wall with wood studding or wood strips, as they weaken the cement by drying it out too quickly when first applied; permit no key or bond at the strips; and permit only a thin coat of plaster over the strips. Such a construction will surely result in cracked plaster and a ruined job.

Mr. Myers's itemized bill of materials for his 12-ft. x 30-ft. silo, complete, follows:

Lumber, for doors and door-frames	\$ 6.31
Nails, for doors and door-frames	1.75
Sand and hauling	12.00
70 sacks Portland cement, at 55 cts. per sack (\$2.75 per bbl.) ..	38.50
Galvanized expanded metal reinforcement	29.40
Combined form and reinforcement for above-ground extension ("Lock-form")	23.40
	\$111.36

Three men on the farm completed this silo in 12 days. They did all the work by hand, and employed no professional labor for any part of the job.

No scaffolding was needed. As is usually done in pit silo work, they excavated about 6' at a time, fastened the reinforcement to the wall and plastered it. No hydrated lime was used, but it is advisable to mix 0.1 part of hydrated lime to 1 part cement. This makes the mortar work more easily and stick better, and adds to the waterproof qualities of the wall.

W. C. Myers's father, J. B. Myers, in the same neighborhood, had just completed a small pit silo 8' x 25', plastering on the earth wall with no reinforcement. After help-

ing on the silo of his son, J. B. Myers also topped off his pit silo with a 4-ft. extension above ground, using "Lock-Form" in its construction. He will re-line the pit, using expanded metal and another coat of cement mortar when the present coat begins to fall off.

The collar around the top of the 12-ft. x 30-ft. silo was made very heavy, being 1:2:4 concrete, 2' wide and 2' deep. It also serves as the foundation for the 5-in. solid wall which will be extended next spring to about 25 ft. in height.

STRUCTURAL DETAILS

The expanded metal used for the above-ground work serves the double purpose of a rigid form and the proper reinforcement for the concrete. No other forms are needed. This combined form and reinforcement reaches the user in sections, which, when snapped together by means of interlocking dovetail corrugations, make the double wall of the form and properly places the reinforcement in the same simple operation. The concrete, usually a 1:2:4 medium wet mix, is then tamped in courses 6" to 8" high clear around the silo. The wet concrete is worked out through the mesh under tamping, curling over and embedding the mesh in the wall. Thus the expanded metal form remains in the wall as the most efficient reinforcement. It is continuous in every direction and uniformly distributed. Where the size of the silo requires more steel than is in the mesh, additional reinforcement is provided by wrapping No. 8 or No. 9 wire around the outside of the mesh immediately after the concrete has been placed therein. This mesh is made in 36-in. widths. After the lower course has been filled with concrete, another course is fitted on top of the first, and immediately filled with concrete. So on to the top of the silo. This is shown in Fig. 2.

SURFACE FINISH

A finish coat of 1:2 cement and sieved sand is applied to the walls inside and out, while the 1:2:4 concrete is still green, so that it cures with the wall as a monolith.

If any reader has a copy of *Concrete Engineering* for July, 1909, which he would part with for, say four months' extension of his subscription to CONCRETE-CEMENT AGE, please write to CONCRETE-CEMENT AGE, Detroit, Mich.

²"Lock-form" is a combined form and reinforcement of small mesh expanded metal made by the Edwards Metal Structures Co., Kansas City, Mo. This material was described in CONCRETE-CEMENT AGE, Jan., 1913, (p. 32) and Feb., 1913 (p. 97).

³Edwards Metal Structures Co., Kansas City, Mo.

Over 40,000 Cubic Yards of Concrete Placed in a Month

In the construction of the Spaulding dam, described elsewhere in this issue,¹ it is of interest to know in detail the record made in placing in the month of Aug., 1913, 40,485 cu. yds. of concrete. The Lake Spaulding dam, which is 260' high, rises up out of a deep gorge, and the mixing plant, material bins, etc., are placed up on the hillside. The concrete is handled by an extensive series of belt conveyors, chutes, towers, etc.

The accompanying table shows the detailed record of the hourly operation of the four mixers used. This shows the operation Aug. 18, 1913, when a total of 20,150 cu. yds. of concrete was placed, using 2,486 bbls. of cement. The table is a reproduction of the daily report of the Pacific Gas & Electric Co.

F. G. Baum, ch. engr., Hydro-Electric Dept., Pacific Gas & Electric Co., San Francisco, in commenting on this run of Aug. 18, states that the concrete was run in chutes several hundred feet and dropped nearly 150' in towers with baffle plates. In discussing the time required for mixing each batch Mr. Baum further states that tests that they made proved that 1½ min. to 2 min. is required where there is any subsequent drop to the baffles. Two minutes was used as a standard mixing time to give good results on the work. Different materials required different mixing times to produce the best concrete and when more cement is used more time is needed.

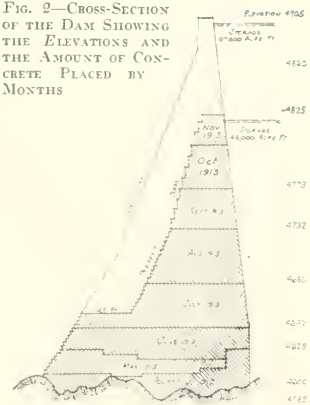
The equipment used in turning out this concrete consists of four No. 14 Smith² mixers, rated 1 cu. yd. each.

The accompanying views, which were taken Sept. 23 and Sept. 24, 1912, show the battery of Smith mixers being swung into place. In the article on the Lake Spaulding dam referred to, the position of three mixers can be seen in the background to the right of Fig. 1 and in the center background in Fig. 5.

The man who will not listen to safety rules may have to listen to the sound of the ambulance gong.

²T. L. Smith Co., Milwaukee

FIG. 2—CROSS-SECTION OF THE DAM SHOWING THE ELEVATIONS AND THE AMOUNT OF CONCRETE PLACED BY MONTHS

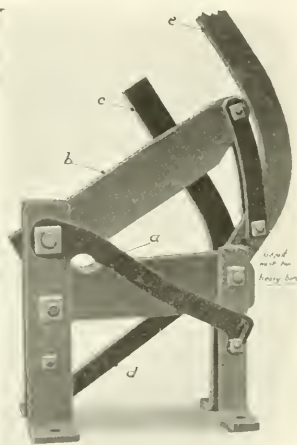


New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

A Compounding Bar-Shear

A bar-cutter built by the Simonson Iron Works, Sioux Rapids, Ia., which weighs 125 lbs. and will cut up $7\frac{1}{8}$ -in. round bars, is shown in the accompanying illustration. The blades are 1" x 4", mild steel, with a body of tool steel welded on as a cutting edge. The "hold-down," *a*, which keeps the bar from flying up, is adjustable for different sized rods. The blade is shown at *b*; *c* is a bar, the extension of one of the legs, and acts as a guide to keep the blades from spreading during the cutting operation. A diagonal brace, *d*, is bolted across the machine to make it rigid. When cutting, the handle, *e*, is pulled down and the pressure on it is compounded 72 times for use at the jaws; i. e., the lever moves 72" while cutting jaws close up 1 in. Recent models are equipped with leverage adjustment for heavy rods. This adjustment compounds the pressure 90 times.

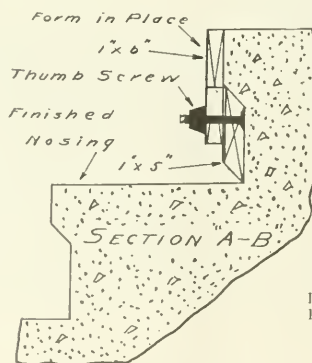


SIMONSEN BAR-CUTTER

together by thumb bolts which go through vertical slots in the upper board. With the use of this form any size of nosing or step can be made.

One Way to Make Nosing on Concrete Steps

The why of a "nose" on concrete steps dates back to the early beginnings of architectural and building technique. A nose gives that wider and overhanging tread essential for the best stair construction. The accompanying sketch shows a detail for making a nosing on concrete steps which has been developed by H. L. Park & Co., Reading, Mass. Mr. Park, in his previous work, has developed an efficient step form and the accompanying sketch shows an adaptation of this form to make nosing. Instead of using a 2-in. plank for risers, two boards are used, held



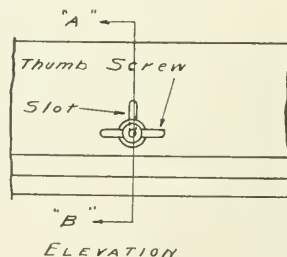
CONCRETE-CEMENT AGE

Tight Doors for Concrete Silos

A door frame and door for concrete silos, which provides a tight seal for concrete silos, or silos built of other materials, are shown in the accompanying illustrations. The manufacturer of this door, the Kalamazoo Tank and Silo Co., Kalamazoo, Mich., emphasizes three advantages, an air- and water-tight seal, an effective horizontal tie, and a ladder the entire height of the silo.

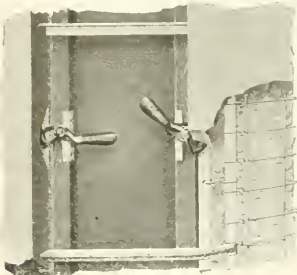
The doors are provided with a heavy wool-felt gasket which extends up and down the outside edges of the door and also between the doors. This gasket is continuous on each door and attached to the lower edge of the door. It is removed with the door and is never exposed to the action of the elements, or acids in the ensilage, or exposed to injury by the fork in throwing out the ensilage.

The sealing of the silo is effected by this door being drawn against the wall of the silo, the felt gasket intervening as does the rubber on a fruit-can seal. The door is drawn against the wall by means of a cam



DETAIL SHOWING ADJUSTABLE RISER BOARD FOR CONCRETE STEPS

latch. These latches are of malleable iron and very strong. The angle-steel door-frames are heavily galvanized after being assembled.



DETAIL VIEW OF SILO DOOR

A Light Batch Mixer

The "Simplicity" batch mixer, built by the Turner Mfg. Co., Port Washington, Wis., is designed to meet the demand of the small contractor, sidewalk man, builder and farmer. It is of equal value to the large contractor who can see the advantage of having a small mixer on the job to finish the odds and ends, and move his large mixer to his next large job.

This mixer has a capacity of 4 cu. ft. per batch. The loading hopper is 40" from the ground; the discharge is just the right height for loading wheelbarrows and forms.

The mixer is of steel construction throughout, with large, durable working parts. The drum is of the non-tilting type, made of heavy sheet steel. The ends are reinforced by heavy angle iron to which the end plates are riveted. A heavy angle iron about the center of the drum reinforces it where the driving sprocket is engaged. The drum revolves on four guide wheels with long bearing surfaces.

The power is transmitted from the

engine to the jack-shaft and jack-shaft to the drum through a riveted and stretched chain belt.

Power is supplied by a 2-h. p. farm engine which can be disconnected and used for other purposes when the mixer is not in use.

The entire outfit is mounted on a substantial steel truck and weighs less than 1,000 lbs.

Baling and Counting Empty Cement Sacks

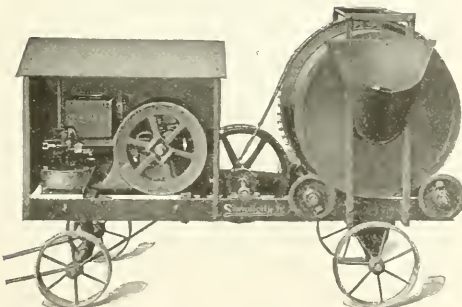
Cloth sacks as cement containers are in many ways a continual and, as it were, an accumulative nuisance. As the job goes along trouble with sacks—sacks lost, errors in counting, etc., gets worse. If cloth sacks are to be used on the job there is really but one practical way to handle them. Just as quickly as the cement is shaken out of the sacks they should be cleaned, counted and packed into bundles for shipment. Contractors are realizing that economy can be effected by placing right behind the mixer a simple bag-bundling equipment of some kind to keep the sacks bundled as the cement is used.

Of interest in this connection is an automatic counting and bag bundling machine made by the Faerberhill Mfg. Co., Cleveland. As shown in the accompanying illustration, this is essentially a well braced, all-steel table on which the sacks can be laid and bundled. When the bag is laid on the bundler it comes in contact with the trigger of a register, which is so located—as shown in the upper left-hand corner of the illustration—that it is more convenient to strike it than to miss it. This register can be set to ring a bell at either 25 or 50; thus, if cement bags are being bundled the register is set to ring at 50, and when bundling plaster bags the register is set to ring at 25.

While the machine is empty the wire ties, either two or three, are placed in position as required. When the correct number of bags is in the machine the handle at the top is pulled forward and down. This rolls the bags solidly together; then the ends of the wire ties are brought together so that both ends are held securely in the "knotter." The handle is now thrown up again and by turning the crank at the front of the machine the wires are twisted together. The ends of the wires are cut off and the bundle is ready to lift out of the machine. These bundles are neat and compact. A bag cannot be pulled out. The shipping tag may be slipped over one of the wires before placing it in the machine, so that when the bundle is lifted out it will be all tagged and ready to ship. The illustration shows a bundle of 50 cement bags on the left and one of 25 plaster bags on the right.

Proportioning Water for Batch Mixers

A feature of interest in the 1914 model of the Schaefer mixer, manufactured by the Schaefer Mfg. Co., Berlin, Wis., is the water tank. This consists of a 40-gal. tank, a three-way valve and an inverted "U." The tank is heavy electric-welded sheet metal, and will stand water pressure up to 200 lbs. per sq. in. Opening the three-way valve completely fills the tank with water from the city main. A quarter turn of the valve shuts off the city main inlet, and allows all the water in the tank down to the level of the top



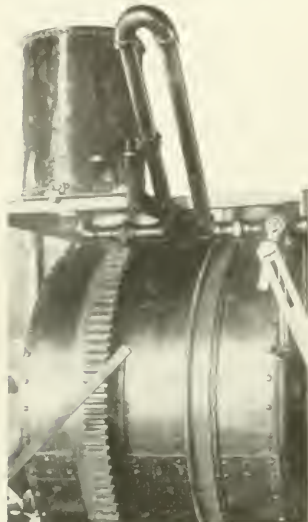
A GASOLINE-DRIVEN SMALL BATCH MIXER



A MACHINE READY TO RECEIVE BAGS FOR COUNTING AND BUNDLING

of the "U" siphon to discharge into the mixer.

When the water level gets below the top of the "U" the siphon is broken, and the discharge stops. Thus the amount of water can be controlled by changing the inclination of the U-bend. The discharge pipe into the mixer is 2½". All couplings are packed.



DETAIL VIEW OF "U" FOR PROPORTIONING WATER FOR BATCH MIXERS

Waterproofing an Orchestra Pit Under Adverse Conditions

The accompanying views show very interesting instances of what waterproof mortar can do in keeping water out. Fig. 1 shows the or-

chestra pit of the Victoria theater at Wilmington, N. C., under construction. The architect, B. H. Stevens, Wilmington, was very much discouraged as to the possibility of getting a dry construction.

CONTINUOUS POURING OF CONCRETE

The contractors pumped out the pit, put up their forms for the walls and, starting at 7:30 a. m., poured the entire floor and walls of the pit in a continuous run. A 1:2:4 mix was used, using ¾-in. stone for the aggregate. The concrete was waterproofed with 4 lbs. of waterproofing compound to a sack of cement.

So far the results have been very satisfactory and there is not apparently a damp spot on the wall anywhere due to seepage. The proprietor of the theater has paneled the concrete walls with wood indicating that there is no danger of the wood warping or rotting from dampness.

Trade Publications □

Concrete Construction—American System of Reinforcing, 10 S. La Salle St., Chicago, 7" x 4½", paper, 24 pp., illust. This is a compact circular describing briefly some elements in concrete design, tables, present data on floor and column design, and the American system of unit reinforcing is briefly described.

Varnish and Varnishing—Lowe Brothers Co., Dayton, O., 9" x 5", paper, 40 pp. This catalog is an artistic, well prepared and detailed presentation of varnish developments. The problem is covered comprehensively and effectively.

Interior Decoration—Lowe Brothers Co., Dayton, O., 9" x 5", paper, 32 pp., illust. This booklet is an artistic and well prepared catalog showing methods of interior finish. Each part of the house is covered in detail. It is illustrated with colored prints.

Hercules Wtfg. Co., Buffalo, N. Y.

Waterproofing Practice—Trus-Con Laboratories, Detroit, 7¾" x 5", paper, 26 pp., illust. This booklet describes in detail waterproofing problems with special reference to an integral waterproofing compound. Many illustrations are shown of work that has been waterproofed.

Elevating, Conveying, Power Transmitting and General Machinery—H. W. Caldwell & Son Co., Chicago, 9¼" x 6¼", cloth, 798 pp., illust. This catalog, which is well bound in cloth and well illustrated, describes in detail a complete line of equipment. In general it can be said that the emphasis is placed on material handling equipment, such as conveyors, chutes, screens, hoists, hoppers, etc. There is also a complete line of transmission machinery described. The catalog makes an attractive appearance.

Practical Homebuilding—North Western Expanded Metal Co., Chicago, 9¼" x 6¼", paper, 40 pp., illust. This is an attractive catalog describing the uses of stucco on expanded metal in residence construction, presenting many interesting descriptions of houses built.

White Cement—Sandusky Portland Cement Co., Sandusky, O., 9¼" x 7", paper, 32 pp., illust. This booklet describes in a very clever way the many artistic uses of Medusa white Portland cement.

Portland Cement Production in 1913

Final figures for the Portland cement industry in 1913, as obtained by the U. S. Geological Survey, Mar. 16, show a production of 92,097,131 bbls., shipments of 88,689,377 bbls. and stocks on hand 11,220,328 bbls. It is somewhat interesting to compare these figures with the estimates made by the Geological Survey Jan. 15. These estimates were as follows: Production 92,406,000 bbls., shipments 88,553,000 bbls. and stocks on hand 11,375,000 bbls., the percentage of error ranging from only .003 in production to about .01 in stocks on hand.



FIG. 1—THE ORCHESTRA PIT WHILE THE WORK WAS UNDER CONSTRUCTION



FIG. 2—THE ORCHESTRA PIT AFTER COMPLETION

Concrete-Cement Age

Vol. 4.

Detroit, June, 1914

No. 6

A Stronger Magazine

AN announcement will be made on this page in the next issue as to future Editorial work of this magazine which we believe will be of great interest to you as a reader, no matter what kind of work you are doing. We are trying of course all the time to make your magazine more valuable to you and to increase your confidence in it as a sort of partner in your individual activities. The present plan, which we shall announce to you next month, has been under consideration for some time as a means of broadening and strengthening the Editorial work of this publication. Now it is nearly worked out, so nearly that we are able to say these preliminary words as to a definite and detailed announcement to be made in the July issue of important Editorial arrangements for greater service to all of our readers.

Less Knowledge, But More to Get It

TWO big road conventions will be held again next fall and winter. Better work could undoubtedly be done by one than by two, but if it appears to be impossible to bring these two organizations together, there is still much satisfaction in the thought that the influence of the two, geographically at least, will be important in an educational way. With the conventions in important centers many miles apart, there is sure to result a certain local advantage in each case. The individual attendance at the two conventions undoubtedly will be greater than could be expected for one convention if the two organizations were combined. And while the sum of the resulting knowledge will not be so great, it will be more widely disseminated.

Fewer Papers—More Discussion

CONVENTIONS can be greatly improved in interest and in the value of the results if there are fewer papers and more discussions. A great convention like that either of the American Highway Association or the American Road Builders' Association should not depend upon one man to cover any one subject. Men who will discuss

various kinds of work and who will elucidate certain problems and relate certain experiences should be sought for as eagerly by the program committees as the men who will read formal papers. There should be fewer papers and more time for each one.

European Opposition to Concrete

TO judge from the continental technical press, the opposition to concrete and reinforced concrete on the part of beaten rivals is by no means confined to America. A recent issue of *Le Ciment*, Paris, publishes the text of a lively controversy between adherents of cast-iron conduits for carrying water and those of reinforced concrete conduits for the same purpose. France, it appears, plans to spend 11,000,000 francs (\$2,200,000) in drainage work on her island of Corsica and will install a system of reinforced concrete pipes. This sum of money has moved the cast-iron pipe people to tears and loud wailings. They cry out that the republic's money is to be wasted, and in support of their assertion they quote Dr. Edward Imbeaux, engineer of Bridges and Roads, who, as long ago as 1901, wrote rather disparagingly of reinforced concrete pipe for drainage works.

Le Ciment did not rest quiet when the uproar rose. It got into communication with M. Bonna, a manufacturer-contractor who had been responsible for some of the works of which Dr. Imbeaux had written without enthusiasm. M. Bonna got in touch with his critic and *Le Ciment* publishes a letter from Dr. Imbeaux which is about as complete an apology as the most irate man could wish. This rather cuts off the one prop upon which the cast-iron people supported their fabric of misstatement. The same champion of reinforced concrete pipe publishes a list of important drainage works executed in reinforced concrete, totaling 415,240 metres (258 miles) and ranging in date of construction from 1901 to the present.

A number of interesting things are suggested by reading the controversy. One is that if you are against concrete construction, don't put your faith in the say-so of a man who has written something that he will have to retract; if you are an engineer, don't write things that you may be sorry for; if you are a paper devoted to cement

and concrete, make a full investigation of criticisms against your material and find out whether or not they are well founded.

The International Engineering Congress

AMONG the topics to be treated in the section on Materials of Engineering Construction at the International Engineering Congress, San Francisco, Cal., Sept. 20 to 25, 1915, is that on "The Probable and Presumptive Life of Concrete Structures made from Modern Concrete." It is expected that this topic will be considered both from the standpoint of the history of such structures, and in the light of the available data as to the chemical and physical actions which take place during the hardening and ageing of the concrete. Its treatment should include a consideration of the destructive influence of the conditions under which the structure exists, such as the effect of the action of frost, sea water, sewage and alkaline waters. It is desirable that it shall comprise reference to cements of special composition which have been used where such destructive influences have had to be met. It is realized that the text itself cannot cover the topic exhaustively or in detail in the space available, but, taken in connection with the supplemental bibliography, the treatment may be made a distinct contribution to engineering literature.

Another topic to receive careful consideration at this Congress is that on "Aggregate for Concrete," which is to cover a review of recent developments in the study of the proper character of materials for aggregate, the effect of minor amounts of undesirable material, the effect upon resulting concrete of washing materials for aggregate and the segregation of aggregate into classified sizes before mixing.

A résumé of the status of the so-called slag cement will constitute another topic, which will give the consensus of experience in its use and of engineering opinion regarding it. The supplemental bibliography should contain reference to articles giving data on which the consensus of opinion is based.

A highly important topic on "Waterproof Concrete" is intended to cover the consensus of present

opinion of engineers as to the best methods of accomplishing the desired results, especially as to the results effected by the use of increased amounts of cement in comparison with the use of special compounds. It is suggested that it may also cover results obtained with oil-mixed concrete. The supplemental bibliography should contain the references on which the consensus of opinion is based.

There has always been more or less contention as to the value of concrete containing additions of finely ground foreign material, among which may be mentioned the so-called sand-cement and tufa cement. It is the intention of this Congress to cover the consensus of present opinion of engineers as to the value of such cements, the supplemental bibliography including the references on which this opinion is based.

The engineer who wishes to compile a specification for hydraulic cement from the requirements which have been laid down by his predecessors engaged on similar work is confronted by a difficult problem. A comparison of various specifications under which hydraulic cements are tested, indicating points of difference, and collating engineering opinion on such differences, will furnish a very important topic for discussion at the International Engineering Congress, 1915.

Permanence Is Essential to Beauty

WHAT is beauty? What is a beautiful home? To define beauty has been the endeavor of many a philosopher, and still we grope to a greater or less extent. The birthplace of Bobbie Burns, a little stone hut, is considered a beautiful place. The homeseeking young couple proclaim the little plain frame cottage "just a little beauty."

Isn't beauty, after all, especially in reference to such a material thing as a house and lot, a matter of the association of ideas, of happy times? Depending on the point of view, a house is beautiful in that it offers, in remembrance of the past, in the joy of the present or the hope of the future, such associations. Leaving the short and swiftly passing present out of the question, and considering only the past and the future, we can

see that *for a beautiful home, structural permanence is a fundamental essential.*

The little stone hut, coming down to us through the past century, has conserved and kept intact its priceless associations. The cottage and what it offers have become a part of the valley of the Ayr.

We average Americans have in the past lost a priceless possession, in that we have had to build our dearest associations and live our lives in temporary, tinder-box structures, which we have, out of courtesy, called homes—houses which, as we know, a defective furnace flue might at any time convert into death-dealing fire-traps.

Today, however, the American home-seeker—or rather seekers, for as we all know they go in pairs—can seek and find a real home, a house that will be a homestead, over which, for instance, vines can be trailed, and left alone—not to be torn loose by profane hands every few years, so that the house can be painted. And the floors and stairs will be fireproof, and fire will be a welcome friend, and not a dreaded master.

Beauty in a home is its clustered associations of the past, and what the future promises in such joys. There can be no such associations, either carried down from the past, or hoped for in the future, unless the home is a permanent structure.

In home-building, permanence is an essential to beauty.

Cities wanting good building codes will find much of value in the recommendations of the Joint Committee on Concrete and Reinforced Concrete, a copy of which may be secured by addressing the secretary of the Am. Soc. of Civ. Engrs., N. Y. C. These recommendations represent the opinion of the foremost engineers of this country and agree substantially with the government regulations in Germany, Austria and other European countries.

In using coloring matter with mortar or concrete, the color should always be mixed dry with the cement, before any sand or water is added. This mixing must be thorough, so that the mixture is uniform in color. After this mixing the combination should be treated in the same manner as ordinary cement.

An Unusual Method of Manufacturing Hollow Concrete Lamp Posts

By C. B. WAGNER

Now that the Panama Canal is nearing completion it seems fitting to call attention to some of the finishing touches—necessary details that are being added to the most prominent part of this stupendous enterprise in a manner which will prove pleasing to the eye without sacrificing anything of their practical value. I refer to the lighting system that will make the operation of the canal possible at night—while lending a fairy-like enchantment to the new water-way in its tropical setting. Even in the intense glare of the mid-day sun these fixtures will lose nothing of their ornamental value, as they break the monotony of long stretches of white concrete walls, at the same time harmonizing by virtue of special design and construction with the general scheme of things, and it is the purpose of this article to describe the manufacture of these fixtures.

For the illumination of the exterior of the lock walls, chambers and the grounds of the canal, are erected, on 100-ft. centers, hollow, reinforced, concrete lamp-posts. The tops of these standards rise to an elevation of approximately 33' above the coping of the lock, and are essentially alike, with one exception, that some have single while others have double brackets or arms, for the center and the side walls, respectively.

These lamp poles are entirely of concrete and each consists of a 12-sided, tapering, smooth surfaced column, containing about $4\frac{1}{2}$ cu. yds. of concrete, weighing in the neighborhood of 9 $\frac{1}{2}$ tons. These are made up in four sections. First, the base or pedestal is cast in place and is 6' 6" high and 3' 6" thick, and is supplied with an outlet box, which contains receptacles for inserting portable lamps and telephone circuits. Second, the post proper, which is 22' 10" long, with a mean thickness of 2' 1". This article will deal with the manufacture of this section only. Third, the brackets, which are 1' in height and extend 4' 6" from the center line of the post. Each arm contains one 110-volt, 500-watt Mazda lamp. Fourth, the top or cap

is a large, hollow ball, 2' in diameter.

In order to manufacture the standards economically, a plant was laid out as shown in Fig. 1, which consisted of tracks, for receiving materials and delivering finished products, and a runway *B*, for wheelbarrows, about 200' long, which was raised 6' above the ground. Inclines were run on one side to bring up the material stored in piles marked *A*; on the other was located a mixing platform, 16' x 10', which was at the same elevation as the runway. This

platform rested on a car marked *C*, which ran on a track parallel to the runway. On one end of this car a small storage shed for 50 bags of cement was built, while on the opposite end was secured a large water barrel which had a 2-in. hose as an outlet. This was necessary on account of time lost in waiting for water.

On the side of the track opposite to the runway were 18 forms for casting the lamp-posts. These were arranged in six sections of three each. Each form rested on three

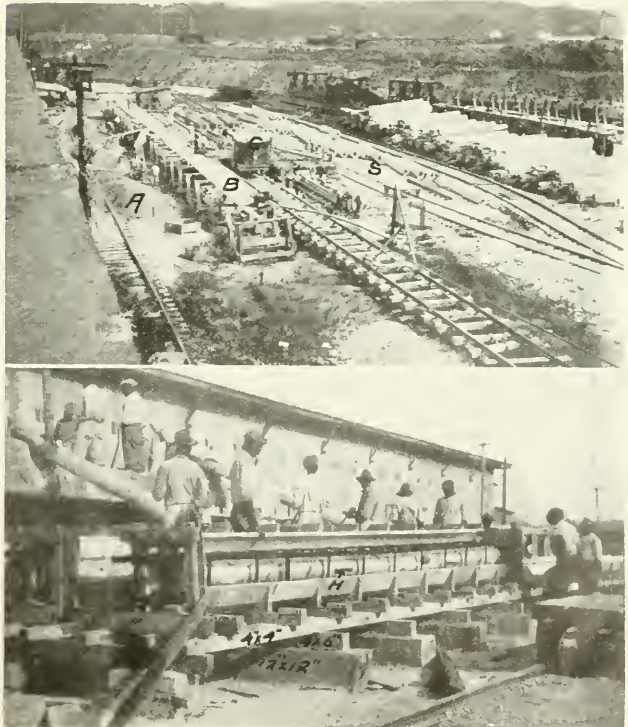


FIG. 1—LAYOUT OF TRACKS, CAR, RUNWAY FORMS AND SO ON

FIG. 2—METHOD OF SHIMMING UP FORMS—ONE SIDE REMOVED TO SHOW TIN CORE, REINFORCEMENT AND PIPES

4 x 4's which ran lengthwise and each section or group of three forms rested on 4 x 6's running at right angles to the 4 x 4's. These in turn rested on 12 x 12's, as shown in Fig. 2. This raising of the forms was necessary in order that the bottom form should clear the ground while rolling the lamp-post casting out of its form.

These forms were made up in five sections: one bottom, two sides and two ends, and were of 1-in. lagging nailed to 10 ribs. The posts, as previously mentioned, were dodecagonal in cross section and had a taper of about $3\frac{1}{8}$ " to 1'. The larger end of each was 2' 6" while the smaller end was 1' 8" between faces. Section No. 1 of Fig. 3 shows the sides *A* and *B* and the bottom *C*. The sides were held together at the top by strips *D*. The form for the core of the post was a conical tin pipe made up of 4-ft. sections riveted together. The reinforcement was composed of four angle irons 2" x 2", 25' long, riveted together by straps $1\frac{1}{4}$ " x $1\frac{1}{4}$ " forming into a tapering skeleton frame. This can be

seen in Fig. 2. This extra length of angle irons was necessary in order to form a bond between the brackets and the bases. The two pieces of pipe marked *H* were left in the post so that it could be easily handled without injury to the standard.

In the process of manufacture the tin core was tied inside of the skeleton reinforcement; this frame was then suspended by the end bulkheads and the sectional forms were put in position around it as is shown in section No. 1, Fig. 3. The concrete was a 1:2 $\frac{1}{2}$:4 mix and was poured into the form through the top side, which was left open for that purpose. Owing to this narrow top, together with the large tin pipe core and the reinforcement, which cleared the form by only $3\frac{1}{4}$ ", there were required, while the concrete was being placed, four men constantly agitating the concrete to keep it from honey-combing.

Four standards were made each day and were left 48 hrs. to set. Then they were removed from their bottom forms by rolling them over, out onto a bed of sand marked *S* in

Fig. 1, and allowed to season for at least a week and then removed to the storage pile by a locomotive crane.

The unusual features of the manufacture of these lamp-posts were the shortness of time allowed for the concrete to set before handling and the method of removing them from their forms. It can readily be seen that the posts could be lifted out of the forms almost any day, by simply inserting bolts, connected to a yoke, through the holes provided for them. But this was impossible unless the standards had been allowed to set for at least 7 das. Had this method, that is, allowing the posts to remain in the forms 7 das., been carried out, it would have required at least 32 forms. Considered from an economical standpoint this was not advisable, but by rolling the castings out in 48 hrs. after pouring, only 18 forms were needed. This number was used, and it is of interest to note in connection with these 18 forms that only four pairs of sides were required, because they were removed 24 hrs. after the concrete was placed.

The method of removing the lamp poles from the bottom forms was as follows: first, removing the 4 x 4 marked 3 shown in section No. 2 of Fig. 3. That the post remained in equilibrium was due to the fact that the timber marked 2 was a little to the right of the center line of gravity, as seen in section No. 1. Second, four wedges were placed on the 4 x 6's, as indicated in the diagram (Fig. 3). These wedges and the 4 x 6's over which the post would roll were covered with several layers of cement sacks to ease any possible jar and to protect the edges from being injured. Four men lifted on the ribs, as is shown by the arrow, and the post turned over. When upside down, the bottom form was removed and the post was rolled out and over onto a bed of sand. The rotation of the post was held in check by having one end of a $1\frac{1}{2}$ -in. rope fastened to a rail and winding it several times around the post and paying out the rope from a snubbing-post.

The distribution of labor and its actual cost and that of the material for manufacturing four posts were as shown in the tables.

The above does not include the cost of preparing the site, use of locomotive crane, or overhead charges.

It is readily seen that these fixtures, standing like giant sentinels, are one of the most prominent and visible features of the canal. I do not intend to introduce any sentiment, yet as pain and death are the



FIG. 3—CASTING THE LAST OF THE LAMP STANDARDS

FIG. 4—LOCOMOTIVE CRANE HANDLING LAMP-POSTS

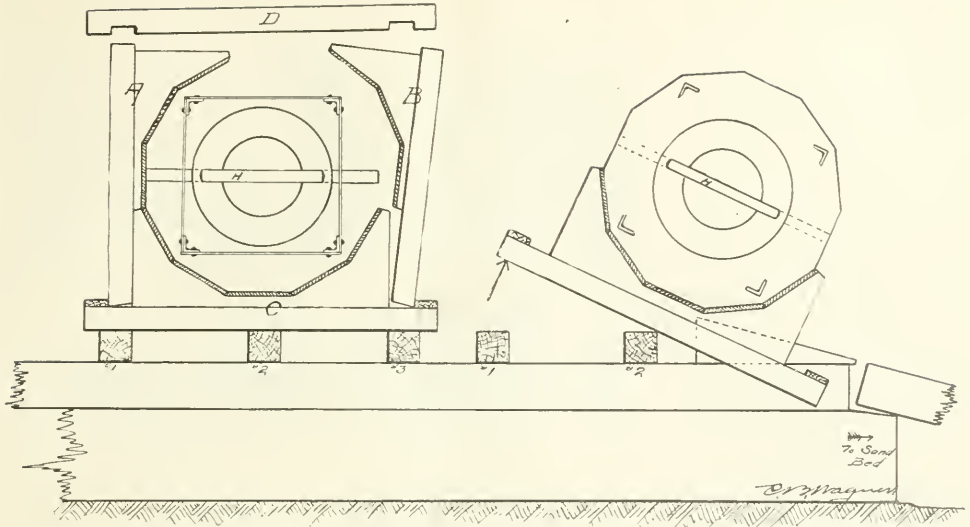


FIG 5—SECTION No. 1 AT LEFT SHOWS METHOD OF PUTTING FORM SECTIONS TOGETHER. SECTION No. 2 SHOWS METHOD OF REMOVING POST FROM FORM

TABLE No. 1—TIME REPORT

Rate	Reinf.	Tins	Labor Distribution					Hours	Cost
			Forms	Material	Mixing	Placing	Finishing		
\$6.00	1.0	....	1.0	....	....	1.0	1.0	4	\$ 2.64
.16	4.5	9.0	9.0	....	4.5	9.0	9.0	45	.720
.13	36.0	9.0	9.0	63.0	42.0	45.0	39.0	243	31.50
.07	4.5	....	....	....	4.5	....	....	9	.63
No. Hrs.	46.0	18.0	19.0	63.0	51.0	55.0	49.0	301	.....
Cost	\$6.38	2.61	3.27	8.19	6.49	7.95	7.17	...	\$42.06

TABLE No. 2—COST REPORT

	Material	Labor	Totals
Cement	\$14.70	\$ 1.17	\$15.87
Rock	6.13	4.65	10.87
Sand	2.04	2.34	4.38
Reinf.	40.00	6.38	46.38
Tins	12.00	2.61	14.61
Forms and repairs	7.20	3.27	10.47
Mixing	6.49	6.49	12.98
Placing	7.95	7.95	15.90
Finishing and storing	7.17	7.17	14.34
Extra supplies	3.00	....	3.00
Totals	\$85.07	\$42.06	\$127.13
Cost per post	\$21.27	\$10.51	\$ 31.78

TABLE No. 3—MATERIALS USED

	Cement—bag	Rock—cu. yd.	Sand—cu. yd.
Quantity	60	9.0	5.5
Cost	\$.21	\$.68	\$.37

Unusual Paving Methods

Some unusual methods in paving are briefly described by Keely Bros., Portsmouth, O., in *Municipal Journal*, as follows:

We had a contract at Welch, W. Va., for 24,000 lin. ft. of curb and gutter, together with 20,000 sq. yds. of brick pavement on a 4-in. concrete base. The streets of Welch are so situated and so narrow that the regularly used method of piling material for concrete ahead and mixing the concrete in the streets, spreading the concrete with the boom and bucket, could not be worked to good advantage, and we decided to

place our No. 14 Koehring¹ boom and bucket mixer near the railroad siding, where the stone and sand (both of which had to be shipped in on cars) were left. Teams were used to haul the concrete to the work, the wagons being loaded by the boom and bucket of the mixer. We used 16 men at the mixer, and three men on the streets to receive the concrete, which was hauled by an average of about five teams with 11½-yd. Troy² dump wagons hauling about 1 cu. yd. of wet concrete to the load. It was a hard matter to keep the teams from getting blocked at times, but for this particular job it proved a very good way to handle the concrete. The same force of men and teams also kept a gang of men building concrete curb and gutter at the rate of about 400' per day. We placed in the street an average of about 1,200 sq. yds. of the 4-in. concrete per day of 10 hrs., and enough concrete was mixed for 400 lin. ft. of curb and gutter, 6 x 12 x 18, at a cost of approximately \$65 per day, which includes the hauling of the concrete. The average haul of the concrete on this job was about 1,500', the longest haul about 3,000'. With the right kind of a location either near a gravel bank or along a railroad switch where the concrete material is being unloaded from the cars and where the cement is handy, I believe that concrete can be very successfully and economically handled by the above method.

¹Koehring Mach. Co., Milwaukee

²Troy Wagon Wks., Troy O.

Simple Architectural Lines Characterize Construction of Concrete School Building

It has been said that the most observing and logical of beings is the child and if this is true it is a condition too often neglected in the training and environment given to children. Some of the things which approach the child most closely are the oftenest neglected as, for instance, the very building which shields it from the weather. Children spend more than half their time, when not sleeping, in a school and too often the impression this building makes on them is all wrong.

That the child does try to comprehend a building with which it associates is often proven. Entering an elaborate recessed doorway of a modern school in the Gothic style the little fellow asks, pointing to the profuse decoration laden with dust: "What are those and what are they for?" And one can only answer that they are to make the building beautiful. There is no way, however, to explain any real need or use of these crudely shaped leaf decorations to a child, and he is not satisfied with your reply. Thus it is with many parts of the structure and usually the answer can be only vague to a child's mind. These things really have a strong effect on a child. He sees nothing very attractive in this building made for his use where "Beauty" seems the ruling factor and where he is hardly allowed to touch anything.

Above all things a school building should be sincere in what it attempts to express. It should not be a wretched copy of some beautiful monument of the Middle Ages as are

most of the attempts at Collegiate Gothic of today, and even less should it be a building of classic detail in which the original function of the members is neglected and insincerity thus becomes the result of a striving for decorative effect. The interior walls should not be cut up with horizontal projecting surfaces, which only serve to catch and retain dust and disease germs. Interior colorings should be light to counteract the darkness of blackboards so that the most may be made of the sunshine received. Above all things else the building should be sanitary and easily cleaned.

Concrete of all building materials seems best adapted to meet these varied conditions necessary to make an ideal school structure. With much useless ornament discarded the forming of concrete becomes a cheap matter. It has greater solidity and adaptability than any other material and the cost of production is much less than that of solid brick or tile with brick veneer. The sanitary properties of concrete in walls and floors are too apparent to need any explanation.

These qualifications of concrete are well shown in the Bishop's School for Girls at La Jolla, Cal. This building was designed and superintended by Irving J. Gill, a San Diego architect. Mr. Gill had a fearlessness in working out his problems which he solves in a progressive sort of a way, causing much criticism at the time the building was being constructed. After a school year's use, however, the new ideas have proven to be very practical, and while architectural effect was made altogether secondary to usefulness in the design, the group is very pleasing.

The building is concrete throughout, walls, floors, stairs and even the stage of the assembly hall. There are no wooden floors over the con-

crete in either the school rooms or the dormitories. The neat top is mottled similar to floors in Italy and rugs are selected to harmonize. The floor color is the same throughout the building. These floors are finished as smooth as possible and then treated with a coat of paraffin, applied hot; this is rubbed down and the floor is then waxed like a wood floor. The resulting surface is satisfactory for dancing or any purpose for which wood floors could be used and does not wear down or discolor. The floor is very sanitary as it absorbs nothing whatever and there are no cracks for dust. This, in a dry climate, is a great advantage.

The floors are covered to form a ground for the plaster on the walls and a base or "mop strip" is painted on the walls of the floor color 4" high instead of using the ordinary base board projecting 7/8" from the wall to form a dust ledge.

These floors are an advantage in regulating temperature inside the building. They heat and cool slowly; so on a hot day the building is cool and the building is warm on a cold day. The interior walls and ceilings are fine sand-finish plaster and are tinted the same everywhere in the building. Warm gray is used for walls and chalk white for ceilings. This, perhaps, would seem monotonous, but in truth the reflected light through the large windows throws the colors from the lawns, flower beds or tile court floors onto these surfaces and no room looks in the least like its neighbor. Each room thus takes on the tones of its surroundings and so softens the colors that the result is very delicate and pleasing.

The walls are not covered with projecting picture moldings, chair-rails and the like. These are made to come flush with the wall of the room. All doors are of the slab type



FIG. 1—TOWER OF BISHOP SCHOOL.



FIG. 2—GENERAL VIEW OF SCHOOL.



FIG. 3—SCHOOL'S OPEN COURT



FIG. 4—FRONT VIEW OF BUILDING

and close into frames which are flush with the walls. Metal door and window frames are used entirely. These are bent from 24-ga. sheet galvanized iron according to details especially for this job. The part of the frames which is cast into the concrete is triangular in section and punched with holes large enough to admit the liquid mass of concrete. These frames are detailed to form the ground for both the interior and the exterior plaster. The great advantage of these frames, of course, is to eliminate shrinkage and also to lessen the quantity of material that is likely to burn, but the appearance is also very neat and sharp in line, which surely is an improvement over the average wood frame casing.

The exterior courts, which are paved with concrete, have proven a very useful feature. These are shaded at times by large canvases slung in a manner similar to the Italian. Thus a fine outdoor study or recitation room is created. The larger court is used for exercising and also by the esthetic dancing classes. These courts are used by the art classes and the light effects are controlled by the canvases.

The bed rooms themselves and their furnishings are plain in the extreme. Everything in furniture is light in color and simple in construction. The walls are not covered with pictures because it is too difficult to hang them. So pictures are few in number and of highest quality. Thus the room is not a jumble of impressions to a child, but rather a refined, consistent and comprehensible force, working for the good of its occupant. In these rooms also sunshine

is used to the utmost. The lightness of the colorings in the sleeping rooms makes the least amount of dirt visible and so servants cannot neglect to keep them clean. This matter is altogether as it should be, for least of all should a sleeping room be unsanitary. The day of making things so as not to show the dirt is past.

The simplicity of the exterior design is restful and very pleasing after seeing so many buildings which are covered with useless and usually senseless decoration. Decoration, except what nature herself chooses to grow upon these walls, is entirely omitted, with the exception of a light colored tile detail about the opening in the top of the tower. As yet the vines have had little time to grow, but the accompanying views are interesting in showing exactly what the architect has done and what he leaves for Nature to do. No idea, of

course, can be had from the illustration as to the variation of color in these large, plain surfaces. La Jolla is close to the sea and glories in sunshine 360 days of the year. This intense light develops color by reflection, until the walls glow so vividly that people ask if they are not tinted. As a matter of fact they are treated with a coat of colorless waterproofing in which is just a small amount of white to even the tone and cover the plaster stains due to alkali. The rest of the coloring is due only to the reflections and changes with the periods of the day in a most delightful manner.

There is a sincere dignity about this combination of straight lines and arches which seems to be a parallel development of architecture along with modern ideas of child education. Useless things are omitted; originality rather than a following of old ideas is visible everywhere. Purity is expressed in line as well as in reality, and it is a structure which is little damaged by use.

Thus has this architect expressed his ideas of a school building and while it suffers the criticism which always attends a departure from the beaten path, each day is showing the true value and criticism is fast taking on an altogether favorable tone. These ideas have been expressed in concrete and this material has again proven its title to a leading place among building materials.

CONSTRUCTION DETAILS

The concrete for this building was placed in wood forms, filled by means of a hoist and chute. This method of placing was not practical for the tower so the concrete was raised in wheelbarrows, through the spaces left for stairs, to the staging from which it was to be poured. The floors of the tower are 6-in. slabs of concrete,



FIG. 5—BED ROOM BISHOP SCHOOL

reinforced with Hy-rib¹ at the bottom of the slab.

The metal door and window frames were placed in the forms and properly braced so as to support the weight of the green concrete and then the material was poured in around these, taking care that the mixture thoroughly penetrated the holes left in the triangular section of the frames. The simplicity of the design made modeling of the plaster coat unnecessary, as this could all be done in the concrete. Considerable expense was saved in this manner and the results are much more permanent than if molded plaster had been used.

The foundation construction had some unique features. The excavations were made in the usual way and the walls were built to within 6" of the tops of the finished concrete floor. The reinforcing was left projecting about 12" to 18" above the tops of the walls, so it could later be laced into the reinforcement of the floor. When these walls had properly set, the inside forms were removed and the outside bracing was strengthened. These walls were from 1' to 2' 6" high, depending on the grade. Then with the exception of the space reserved for heating in the basement, this space to the top of the wall was filled with earth, well settled with water and tamped down. This work is indicated on the architect's drawings as "Fill, tamp and puddle." When the settling had ceased, a 2-in. layer of concrete was spread over the entire area. A small mesh Clinton wire fabric² was then spread over the fresh concrete and laced to the wall reinforcement, which projected from the walls; and then 3" more of concrete was added. The wall construction then proceeded on top of the rough concrete floor. To this surface was added, when the building was nearly completed, the finished concrete floor.

One way of getting the good results on this work was the manner in which it was superintended. The specifications instead of giving a definite formula for the mixture of the concrete required that samples which were constantly taken from the forms should test to various tensile strains, at the end of nine days. The required strength of these different mixtures was of course governed by the place where the concrete was to be used. These test briquettes were made by the architect's superintendent every day, of a mixture taken after it had been poured and at any



FIGS. 6 AND 7—INTERIOR VIEWS OF CONCRETE SCHOOL BUILDING

time he happened to appear on the job.

The strengths of various mixtures are well understood by good concrete men and this method of specifying brings their experience to the front and also safeguards the construction. Considerable expense was saved by varying the proportions of the concrete.

Samples of the cement were constantly taken and tested before the shipment was used. A neat cement briquette was subjected to a tensile test at the end of 24 hrs. Cement was also tested by boiling a feather-edged plaque of neat mixture which had been formed on greased glass.

The sand was put through the meshes of a laboratory screen and this material was purchased where the required quantities of the samples had passed and been retained on the specified meshes.

This way of being very sure of the quality of material made it possible to use smaller proportions of cement in the work and also to keep the reinforcing steel to the minimum quantity. Concrete is usually made a great deal over size in order to allow for poor material that may be used.

The amounts saved on this building paid many times over for the expense incurred by superintending and testing.

The manner of mixing the ingredients for concrete varies widely. Some contractors mix the materials dry until a uniform color and appearance are secured before the water is added. Others put in the material and the water at once. Either way will produce good results except for hand mixing, where the mixing of the materials in the dry state is the general practice. It may be stated, in general, that if too much time is not consumed in the mixing, a good result can be obtained in any of the many ways practiced, if only the mixing is thorough.

A T-beam must be deep enough to prevent overstressing concrete in the flange.

Dry concrete, i. e., a mixture of aggregates and cement without water, should not be employed in laying concrete under water.

¹Trussed Concrete Steel Co., Detroit

²Clinton Wire Cloth Co., Clinton, Mass.

Notes on Motor Trucks as Modern Construction Equipment in the Movement of Materials

Power mixers, power hoists, power sawmills, power equipment of all kinds in the construction field seems to indicate that the use of power wagons for conveying materials is merely a normal step forward in equipment development. The most radical feature of this development is the use of a central mixing plant and motor trucks to carry the mixed concrete. The next few years will probably see much interesting work along this line.

The motor truck, the power-driven commercial vehicle that is revolutionizing delivery systems in more than one field of endeavor, can it be used to advantage by the building contractor? Will the economy which it will effect—provided it does effect a saving—be sufficiently great to warrant its use? In other words, will the motor truck enable the contractor to underbid his competitors who are more conservative with regard to their mode of delivery, and enable him to increase his business?

The motor truck in the hands of the contractor—and it is well to add right here that the contractors who do make use of the vehicle are few and far between—has demonstrated that it is a means of effecting marked economy when used on long-haul work; also it has been amply demonstrated that used on short-haul work under conditions that were unfavorable it may be the means of effecting considerable loss. The whole subject hinges on the character of the work and the length of haul.

MOTOR TRUCKS IN TERMS OF HORSE HAULAGE

The average 7-ton motor truck has a capacity of about 5 cu. yds. Its first cost is substantially three times that of a horse cart of like capacity with the horses and all the necessary appurtenances. Likewise its fixed charges—the interest on the money invested, insurance, depreciation, storage and the wages paid to the driver—sum up practically to three times what the corresponding items aggregate when the horse-drawn

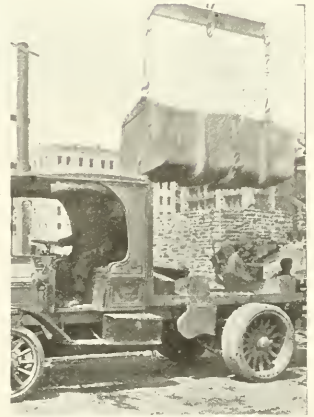


FIG. 2—USING MOTOR TRUCKS WITH ADJUSTABLE BODIES ON NEW YORK SUBWAY WORK

5-cu. yd. truck is considered. Obviously if the motor truck is to be of advantage, it must prove capable either of transporting an amount equal to three times that carried by the horse vehicle during a given interval at less operating expense, or else it must be able to carry more than three times the aggregate carried by the competitive vehicle at the same cost for operating. The operating expenses in the case of the motor truck embrace the cost of fuel, lubricant and repairs, including tires; those for the horse-drawn truck include the feed bill and the repair bill.

When it is reasoned that the motor truck is easily three times as speedy as the horse-drawn vehicle, and that it can, moreover, be kept practically in constant service, it would seem that the task of proving its advantage over the lighter vehicle is a comparatively easy one. And so it is on long-haul work, as more than one contractor has discovered to his own gain. But it will at once be apparent that anything which entails delay limits the work that a motor truck, or any other truck, for that matter, can do and consequently limits its efficiency. Frequent loading and unloading naturally occasion delay and while the same is true of the horse vehicle, in the case of the motor ve-



FIG. 1—MOTOR TRUCKS USED TO HAUL CONCRETE FROM A CENTRAL MIXING PLANT FOR THE NEW YORK SUBWAY



FIG. 3 A TYPE OF BODY DUMPING MOTOR TRUCK IN USE IN NEW YORK CITY

hicle the loss incurred when the motor is inoperative amounts to three times that occasioned when the horse vehicle is held up. Moreover, on short-haul work, the motor vehicle has not the space to reap the full advantage of its speed capability, while the speed of the other vehicle is hardly impaired.

TRUCKS ON N. Y. SUBWAY WORK

It quite naturally follows that to use the motor truck to real advantage on short-haul work, the delays entailed by loading and unloading must be reduced to a minimum. With the contractor placing concrete or carting the ingredients for concrete, it is short-haul work that is entailed in a great many cases. But it has been demonstrated that it can be made to do work more economically than the horse cart, even where conditions are not altogether favorable to the power-driven vehicle, by the case of Patrick McGovern & Co., 1 Madison Ave., who have a pair of 7½-ton Mack trucks¹ doing concrete hauling on various contracts in and around the city.

The McGovern Co. tackles the job of facilitating loading and unloading the vehicle in either of two ways, according to conditions. The first way and the one usually used where the job in hand is a large one calling for a considerable amount of concrete, is illustrated in Fig. 1. The loading problem is solved by elevating the concrete mixer on a suitable framework of timber and arranging it so that it empties into a funnel or hopper of about the same capacity as the truck, the mouth of which is so located that it empties into the body of the vehicle when the latter is backed into place beside the structure. When the truck arrives for a load, it takes but a moment or two for it to be positioned under the mouth of the funnel-like hopper,

when the gate is opened by the man in attendance and the full load pours into the body of the truck. The whole operation takes but a fraction of a minute, so that it is not necessary for the driver to shut down the motor.

Dumping, of course, is taken care of by the truck itself. The body is held on a framework which is hinged at the back and which is raised in a comparatively short space of time by a tilting mechanism operated by the motor. This arrangement comprises a pair of chains arranged to wind upon a drum placed immediately behind the driver's seat, which is arranged to be geared to the engine through the gear set when the driver engages an extra sliding gear by means of the gear-shift lever. The ends of the chains are shackled to the lower ends of a pair of arms reaching down from the tilting framework. The whole operation of dumping consumes hardly more time than loading, so that the work at either end is facilitated.

The other McGovern method of handling mixed concrete is shown in Fig. 2. The truck, instead of being

provided with an automatic dumping body, is fitted with a simple platform body. A pair of substantial skids is placed across the platform for the purpose of holding a bucket. The bucket, which is of 5 cu. yds. capacity, is swung into place on the truck by means of a derrick and rests on the skids, being kept from shifting by its own weight.

The loaded bucket is picked up at the point where the concrete is mixed—obviously the mixer need not be elevated, for there is plenty of time for the bucket to be loaded—and carried to the point where the substance is to be used and deposited. The truck then picks up an empty and carries it back to the mixer. Three buckets are required to keep one truck busy and the time lost at the ends of the trip is reduced to the minimum.

Obviously for work of this sort the motor truck equipped with a dumping body will be found particularly advantageous, unless the bucket is used to carry the load. But though there is some little advantage gained in the way of time saved by the use of the automatic dump body, the John F. Stevens Cont. Co., N. Y. C., finds that the hand-operated type possesses certain advantages in the way of simplicity and reduced first cost, while the time taken to lift the body in place again after the load has been deposited is not materially longer than is the case with the engine-operated dump. The Stevens truck, a 5-ton Locomobile² with a capacity of approximately 4 cu. yds., is shown (Fig. 3) both with the body in place and dumped.

Fig. 4 shows a 5-ton White³ truck with dumping body automatically operated by the motor. The dump-

²Locomobile Co. of America, Bridgeport, Conn.

³The White Co., Cleveland



FIG. 4—AN AUTOMATIC DUMP TRUCK IN COMMON USE

¹International Motor Co., N. Y. C.

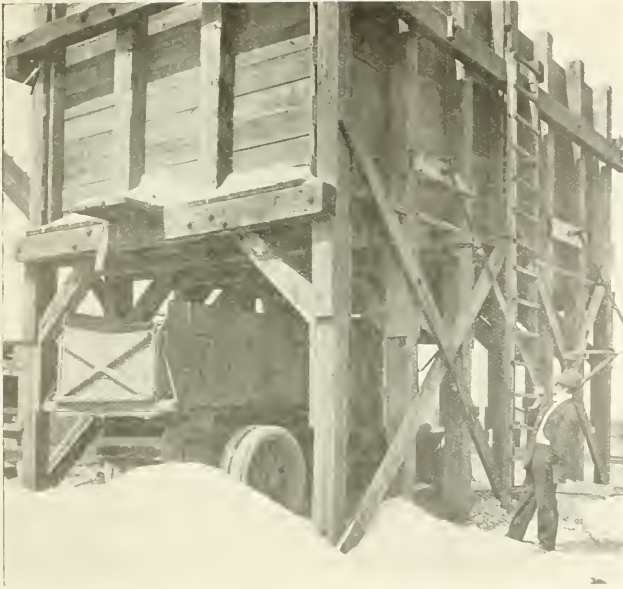


FIG. 5—CONCRETE MATERIAL HOPPERS ON THE BRIDGE APPROACH WORK OF THE NEW YORK CONNECTING RAILWAY

Motor trucks are used for handling the materials

ing mechanism is not unlike the arrangement on the Mack truck, but the lifting mechanism is placed further back on the truck so that the body is lifted at about the middle of its length and the angle of inclination is considerably greater. The tilting angle, by the way, is a point of no little moment when concrete is being handled, for unless the body tips sufficiently far to permit the material to run out freely, it will be necessary for a man to drive down the portion of the load that remains in the body, which of course means time lost, and operating cost raised. A 5-ton Mack truck which is doing service hauling concrete for the Hugh Nawn Cont. Co., Boston, can discharge a load of crushed stone very quickly. The driver shifts a lever, lets in his clutch and the body tilts and deposits the load. Again shifting the lever, the body drops into position and the truck is off without a man having touched the material.

HANDLING MATERIALS ON BRIDGE WORK

Some idea of the real service which the T. A. Gillespie Co. is getting

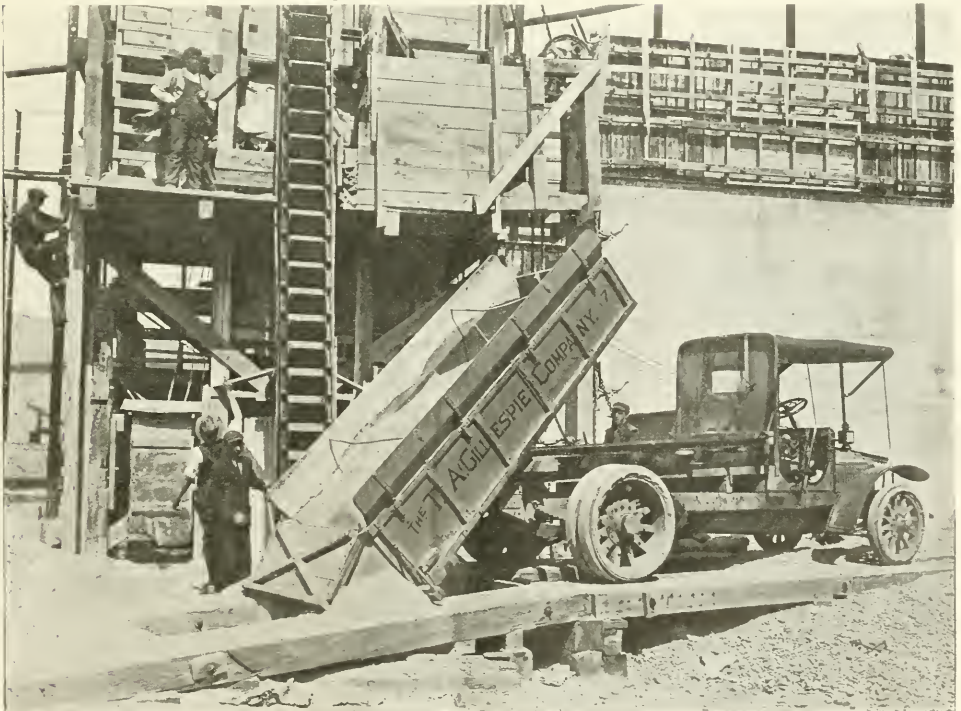


FIG. 6—THE MOTOR TRUCK SHOWN IN FIG. 5 DUMPING INTO THE BOOT OF A BUCKET ELEVATOR

from its fleet of Sauer trucks⁴ is shown by Figs. 5 and 6, depicting the construction of the approach in Long Island of the bridge of the N. Y. Connecting Rys. Co., for which the Gillespie Co. has the contract. The contract, which is a large one calling for the use of a considerable amount of concrete, necessitates the mixing of the material on the spot, so that the trucks are not used directly for the transportation of mixed concrete, but for handling concrete materials. The haul being a comparatively short one, it has been found particularly advantageous to facilitate the loading and unloading of the trucks so that the full work is derived from the use of motor transportation.

The means of loading is shown in one of the accompanying illustrations. Two very large timber hoppers with capacities for about half a barge load of material were constructed at an inlet handy to the barges which are used to bring the material to the point. A derrick serves to unload the materials from the barges into the hoppers. The hoppers are of such height that the truck can easily run right under the span. A gate operated by means of a long lever, as shown in Fig. 5, serves to control the flow of material into the truck body and the operation of loading consumes but a moment.

Even more elaborate means have been taken to hasten the process of unloading. As is clearly shown, a low bridge-like structure has been erected and the truck is driven up an incline to this point before dumping. The sand or the gravel drops onto the inclined chute placed in a pit underneath the bridge-like structure, whence it is carried to a bucket conveyor which elevates the material, dropping it into a hopper at the top of the bins, from which it is used as required by the mixer. The capacity of the conveyor is such that it will empty the boot, which holds just about a truck load, in a very few moments, so that one truck after another can dump its load without delay. The material is not handled by hand at all.

ELECTRIC POWER TRUCKS

At least one N. Y. contractor is having a measured amount of success with the electric motor truck. This is the Clarence I. Smith Co., which is making use of five Couple-Gear⁵ electric trucks ranging in capacity from 3 cu. yds. to 5 cu. yds. One of the many claims made for the



FIG. 7—Using Power Driven Front Trucks To Convert Ordinary Wagons Into Power Conveyors

Couple-Gear electric is that by its use the necessity of scrapping the horse vehicle equipment is avoided and a considerable saving is thus effected. The Couple-Gear equipment comprises simply a pair of wheels and a front axle and suspension system, including steering means which are substituted for the front wheels and shafts of the horse vehicle; a battery of capacity which varies with the work to be done is carried in a suitable battery case positioned on the body. The electric motors are contained inside the wheels, which are of the disc type, being set longitudinally with relation to the truck and geared to the wheels at a point near the periphery. The motor shaft is set at a slight angle so that a pinion at one end engages with teeth on the outside disc, while a pinion at the other end engages with teeth on the inside disc. The gear reduction through the gearing amounts to 25 to 1 and the mechanical efficiency is said to be 97%.

That the use of such a vehicle does pay well is demonstrated by the experience of the company in question. It was found that the truck in service would do actually 125% more work than a two-horse truck which costs \$7.00 a day to operate. The operating cost of the electric truck, all considered, was figured at \$8.75 a day. In other words, by comparison with the horse truck, the motor truck, for \$8.75, did the work that it would cost \$14 to have done by the horse-drawn vehicle.

One feature that is claimed for the electric truck which is foreign to the gasoline truck is the fact that the old horse drivers who have been found reliable can very easily be trained to operate the vehicle. Unlike the gasoline truck, however, the electric truck cannot be used for 24 hrs. in the day, for it must be laid up for the batteries to be charged. This is a minor point which could be

very easily solved and which, in fact, has been solved where it is necessary for the truck to be in constant service, by the use of easily replaceable batteries in sets, one set to be charging while the other is being used. The mileage which the ordinary battery will give on a single charge varies from 35 to 50 miles, according to the character of the load and the character of the ground.

Shop Marks on Bent Bars

All bent bars shown on reinforced concrete drawings should be given some reference mark, which should consist of capital letters and numerals, or numerals only. The following scheme is suggested: For the first 3/8-in. bent bar mark it 300, the second 301, and so on; mark the first 1/2-in. bent bar 400, and so on. For 5/8-in. bent bars use 500, 3/4-in. use 600, and so on. The hundredth figure will indicate at once whether the bar is a 3/8-in. bar or a 7/8-in. bar; thus 703 would indicate that 7/8-in. bars are to be bent and probably it is the fourth in the series of 7/8-in. bars having different bends.

Announcement is made of the fourteenth annual six weeks' summer school of the Coll. of Engrg. of the Univ. of Wisconsin, Madison, which opens June 22. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical, drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which subjects may be taken in the College of Letters and Science.

Do not get used to danger. It may remind you with an accident.

⁴International Motor Co., N. Y. C.

⁵Couple-Gear Freight-Wheel Co., Grand Rapids, Mich.

displaced earth, it came to rest at a final angle of 27° from its original vertical position. Practically no structural damage at all was done to the concrete in either the bins or the workhouse and the workhouse still remains absolutely intact in its original position.

FOUNDATION CONDITIONS

The soil of the Red River valley, in which both Winnipeg and North Transcona are situated, is very treacherous for foundation work, consisting principally of a deep stratum of stiff blue clay with some shallower strata of water-bearing white clay overlying limestone bed-rock at various depths. The treachery of the soil and bad working conditions have often been encountered around Winnipeg, the most notable case until this one being that of the Provencher St. bridge over the Seine river (a small tributary of the Red) in St. Boniface. Diamond drill borings at the site of the North Transcona elevator indicate that 35' of stiff blue clay, 7' of soft white clay and boulders, 7' of firm white clay and gravel, and 4' of shattered limestone embedded in marl overlie limestone bed-rock at a depth of 53' from the prairie level.

THE UNDERPINNING WORK

The Foundation Co., Ltd., has, at present, a force of men engaged in underpinning and shoring the workhouse; this work must be done before the more difficult operation of straightening the bins is attempted. Concrete shafts or piers are being sunk to bed-rock under the workhouse and, in addition, shoring cylinders



FIG. 1—AN END VIEW SHOWING PLAINLY THE INCLINATION OF THE GRAIN ELEVATOR

A Report of Progress in Straightening a Tilted Grain Elevator

BY ALEXANDER ALLAIRE¹

In the Dec., 1913, issue of CONCRETE-CEMENT AGE, p. 259, the subsidence of a great reinforced concrete grain elevator in the Canadian Northwest was described. This elevator settled and "tipped over" 27° from the vertical. The reinforced concrete bins were, it was said, without a crack, structurally intact; and plans were made to underpin the elevator and jack it back into position. The progress of this work is described in the following notes:

The foundation Co., Ltd., Montreal and Vancouver, is at present engaged on a most unique and remarkable work at North Transcona, near Winnipeg, Man., in connection with underpinning and straightening the new Canadian Pac. R. R. grain elevator, the foundations of which failed last fall when the building was being filled with grain for the first time, causing the storage bin section to settle and tilt over to one side to a final angle of about 27° from the vertical.

THE SUBSIDENCE

The elevator, a huge reinforced concrete structure with a capacity of

1,000,000 bus. of grain, is composed of two elements,—a workhouse 70' x 96' in area and 180' high, and a storage tank section 77' wide, 200' long and 90' high, being made up of five rows of 13 tanks in each row. The structure was built in the summer and autumn of 1912, but was not put into service until Sept., 1913, when it was needed to assist in handling the tremendous grain crop of the Canadian West. A slow and uniform settlement took place under the increasing load until Oct. 18, 1913, at which time it contained 875,000 bus. of grain and had settled approximately 3". The storage bin section of the building, on the above date, listed toward one side and settled rapidly until, by the reaction of the

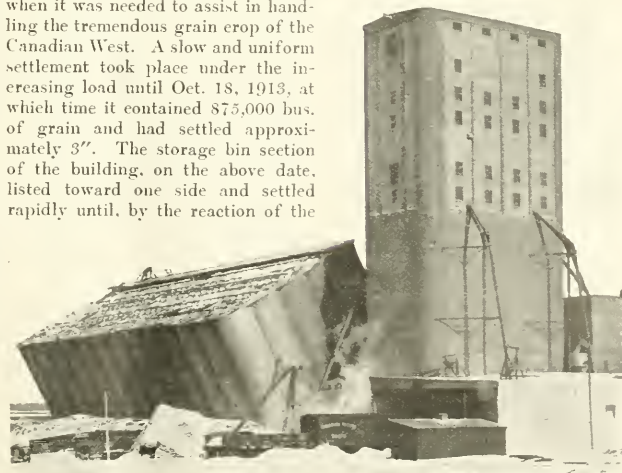


FIG. 2—A GENERAL VIEW OF THE GRAIN ELEVATOR, SHOWING THE TOPS OF THE TANKS

¹Western Mgr., The Foundation Co., Ltd., Vancouver, B. C.

have been placed all around it so as to brace the building from the outside. Flowing water is being encountered in the shattered limestone and white clay strata, but no time is being lost on this account.

When the stability of the workhouse is ensured, the interesting feat of straightening the bins will be started. Excavation will be carried on under the high side of the building to lower it back to approximately its former position. It will then be underpinned by concrete piers extending down to rock. The total load

on the reinforced concrete mattress (27" thick) forming the present base of the structure is practically 13,000 tons when the tanks are empty and the weight of the overhang beyond the perpendicular is approximately 2,300 tons. It is clear, therefore, that the greatest care and caution will have to be exercised. The Foundation Co., Ltd., however, has had a long experience in shoring and underpinning tall and heavy structures and estimates that the building will be restored ready for use by the month of Oct., 1914.

purpose are such that use enhances the value and permanency of that material. But when we make a good concrete pipe and put it under ground and fill it with water, we have given it the very environment which will develop its greatest perfection and have subjected it to a service which of itself will indefinitely prolong its life and insure its permanency. Concrete pipe systems in southern California which have been in constant service for 28 years, are today harder than granite, sound from end to end, and show the unworn marks of the core molds with which the pipe were made. All other materials used for carrying water are at their best when first put in the ground and must deteriorate, more or less rapidly, to the end.

So first and chiefly, the pre-eminence of concrete pipe as a water conduit is based upon its remarkable fitness for the service required, which is not even approached by any other material.

THE CHEAPEST PIPE

To this must be added its low cost, which is again an unusual condition, for though the best is the cheapest in the end, it is seldom the least costly at the beginning. Concrete is nearly always cheaper to install than any other water pipe, not only because its manufacture is an inexpensive process, requiring but little plant and easily obtained materials, but because it has to bear no transportation

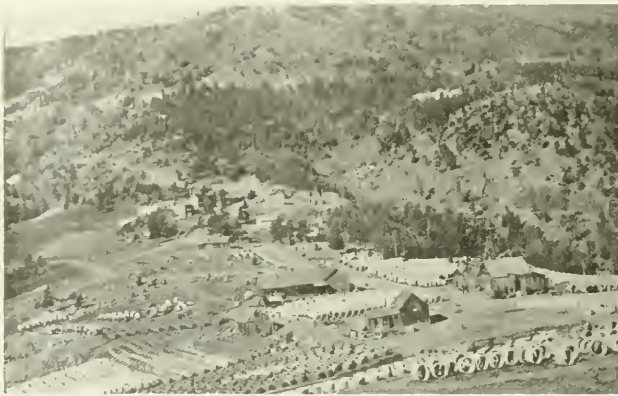


FIG. 1—A 36-IN. PIPE CAMP AT ALTITUDE OF 7,500'

How Concrete Has Helped Develop and Been Developed in the West¹

By ARTHUR S. BENT²

A lifetime ago the semi-arid West was a desert. All of its marvelous possibilities lay dormant and largely unguessed. The climate was ideal, the land was fertile, and in the mountains lay a bountiful and unfailing supply of water. To bring these together was the problem. A medium must be found which would be inexpensive to construct, easy to maintain, certain in its operation and permanent in character. No demand of the human race was ever more splendidly met than when concrete pipe, the one perfect water conduit, came to fill this need.

And so concrete pipe has played a part of tremendous importance in

the wonderful history of our semi-arid West and Southwest and is destined to be a most vital factor in their future development. In this domain of marvelous possibilities it is now and always will be the connecting link between stored water and the land, and absolutely essential in this capacity because no other water conduit known can fill the mission so well. While the economical and satisfactory handling of water was but a short time ago an unsolved problem, today it is so perfectly solved by the modern concrete pipe irrigation system that we cannot conceive of any further development in this direction.

First of all, no other water conduit is so ideally adapted to its work. Indeed, few uses of material for any



FIG. 2—HOISTING PIPE TO GRADE FOR CENTRAL COLORADO POWER CO. 36-IN PIPE LINE

¹Abstract of paper presented at convention of Interstate Cement Tile Mfrs. Assn.

²Los Angeles, Cal.

charges except for the cement. The pipe itself is very rarely shipped in the West. It is made on the ground wherever that ground may be, and in the rough, inaccessible mountain regions, where water must chiefly be sought, it is usually the only type of construction that can be economically considered at all. In such locations we are able to manufacture the pipe in the bottoms of the great canyons, where both gravel and water are to be had, and hoist it by cableways to grade on the mountain sides, there rolling it along the trench to position.

This cheapness and availability of concrete pipe make it an important and indispensable factor in the development of new regions, where land values are at their low stage, and it is not too much to say that without it, certain sections, now highly prosperous, would have remained the homes of the hardy pioneers only.

But while concrete pipe, because of its availability, is the forerunner of land development in the West, it has not been left behind in the later rapid march to intensive cultivation, for it is today the indispensable adjunct of the orange and lemon groves of California, where values reach \$4,000 an acre. On such lands, where the conservation and economical handling of water is the very life of the industry, and where the citrus orchardist stops at no expense which will produce results, concrete pipe is the universal, almost the exclusive, water conduit.

So it is strictly within the truth to say that the marvelous development of the irrigated West could not have taken place as it has without that efficient handmaiden of agricultural prosperity, concrete pipe.

30-YEAR-OLD SEWER

About 30 years ago the first crude attempts were made in southern California to manufacture and lay concrete pipe lines for irrigation. Portland cement at that time was not manufactured in the West and the imported cements cost about \$8.00 per bbl. Knowledge concerning the use of cement was meagre and imperfect and still less was understood of the importance of the quality of sand and gravel and of the curing. Not long ago the writer ran across a man who had worked in one of these early pipe yards and from him learned that they mixed the pipe 1:7, punched it with laths into molds made out of stove pipe iron, propped it up with damp sand after being stripped, and finally lowered it tenderly into

its grave with barley sacks, because it wouldn't bear handling. And yet, remarkable to relate, some of the pipe so made served the city of Los Angeles for 31 yrs. as a main sewer. Sewer pipe, mark you! Not water pipe. Sewage, which according to our clay friends, will dissolve, disintegrate, fletcherize and spit out the very best concrete, in about two years' time.

Of course it was inevitable that the great demand for concrete pipe which rapidly developed, should result in much poor work, some of it ignorant, some of it dishonest. Scores of miles of lean pipe, dry mixed pipe, dry cured pipe, pipe made with dirty or badly graded materials, were rushed into the ground, being no less carelessly laid. Failures resulted by the wholesale. This gave the clay interests their day and for a few years considerable vitrified pipe was sold in some localities for irrigation use. But engineers and the public generally were learning to put their trust in properly made concrete and also learning how to make it properly, and for the last 15 years no question has been raised as to the value and success of concrete water pipe. The fight against it now has centered on its use for sewers. But here also it is steadily and surely making its way, certain of ultimate success, and menaced only by the ignorant or careless methods of its friends. It is conservatively estimated that in southern California alone there are in use 5,000 miles of concrete pipe.

Our own work has extended over the entire West and Mexico, including important lines in the most difficult parts of the Rocky Mountains of Colorado, at altitudes of 5,000' to 7,500', and through burning deserts below sea level; in the mountains of Mexico with Mexican labor, and on the western Mexican plains, with Indian labor; in zero weather in Oregon and in a temperature of 120° to 130° in Arizona. It has been hauled with ox-carts and motor trucks; on mule back and by cableways; on skidways, and sleds. It is laid through tunnels, under railway systems, along rock cliffs, in ocean sands, across trestles, under water and through alkaline swamps. The mere mention of these conditions suggests the marvelous adaptability of concrete pipe and opens up a vision of the tremendous and ever-increasing field of usefulness before it, a field absolutely unlimited if we in whose hands it lies, only are wise enough intelligently and conscientiously to develop the industry.

A RECIPE FOR PIPE

There need be no failures under any conditions. The recipe for success is simple. Use tested cement. Use sand and aggregates that have been passed upon by some competent engineer and proportion them according to his instructions for securing the greatest possible density. Mix your concrete 1 part cement to 3 parts of combined sand and aggregate. Use only a power batch mixer and be sure the batch is of a perfectly uniform color before water is added. Use approximately one-half as much water to a batch as you do of cement. Feed the concrete into the molds as uniformly as possible, in layers that will not be over 2" thick when tamped hard with a heavy iron tamp having a thickness three-fourths the thickness of the pipe shell and a face length of 4" to 6". Don't patch up any cracks—take such pipe down at once and remold. Keep the pipe constantly wet for 7 days—never allowing it to turn gray. Then coat it on the inside with a neat cement paste so thick that it will scarcely drip off the brush. Don't let any pipe get below 45° above zero during the first three days. This roughly-described method will give you a pipe that you can safely guarantee for low water heads, say from 10' to 20', according to the size, and can guarantee against the action of alkalis or sewage, or any other unfavorable condition.

The chief points wherein the above specifications differ from ordinary practice are the slow feeding and the wetness of the mix, and on this last too much emphasis cannot be placed. Most failures are due to dry mixed pipe. The manufacturer who for the first time attempts to use the quantity of water here mentioned will be discouraged by the inability of his men to get the molds off without cracking or destroying the pipe. He will probably feel that it can't be done. For his encouragement it should be said that we have trained our men in this direction until they can turn out as many feet of this very wet and sticky pipe as they once could of the dry pipe, and we make it wet to the point of distortion. We go even beyond this, using a band around the top of the pipe immediately when the jacket or case is stripped, to take care of the distortion which we otherwise could not prevent. Making such wet pipe will increase your difficulties, increase the weight of your pipe, reduce the number of feet you will get from a barrel of cement, worry your men and reduce your profits until your vastly

improved quality begins to be recognized and demanded. After that you will say it is the best move you ever made. You will be able to demonstrate, as we have done, that the very best concrete made is that which is just as wet as can be compacted by a blow. Wetter than that is not so good (though it must be so used when reinforced), and dryer than that is still poorer. By such methods we are able to produce 18-in. pipe with a 11 $\frac{1}{8}$ -in. shell that will stand 125 lbs. to 150 lbs. water pressure, and this without any reinforcement or waterproofing whatever, and 30-in. pipe with a 21 $\frac{1}{2}$ -in. shell, standing 25 lbs. to 60 lbs.

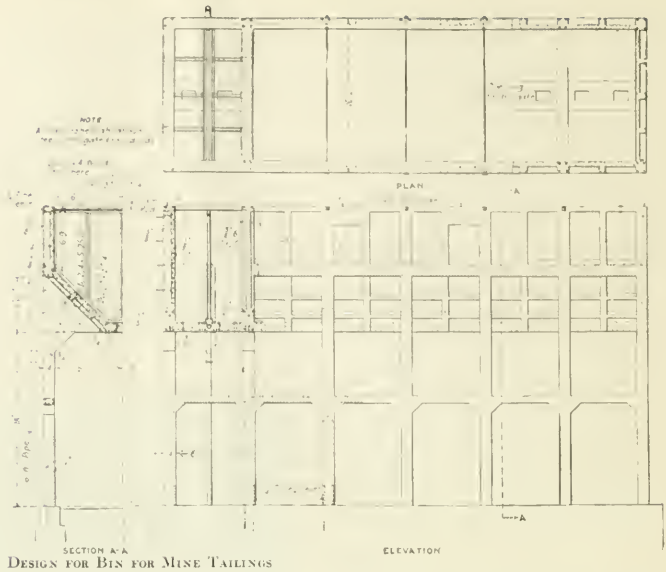
Concrete Bin for Mine Tailings

At the Leadville mill of the St. Joseph Lead Co., and at Mill No. 3 of the Doe Run Lead Co., near Rivermines, Mo., bins for holding mine tailings have been erected and are described in a recent issue of the *Engineering and Mining Journal*. A 1:2:4 concrete was used, reinforced with corrugated¹ round high-carbon bars. The design called for a rather complicated form of reinforcement, end hooks being used very extensively, and the reinforcement was tied together with wire, using 10-ga. to hold the steel in proper position relative to the forms, and 16-ga. to tie the steel. The vertical posts, as well as the cross-beams that reinforce the hopper bottom of the bin, were strengthened by wrapping the main rods with 1 $\frac{1}{4}$ -in. plain rods as straps to tie the main rods together. This rodding is tied around only one of the bars in each loop of the spiral, but as in the next loop it is tied around the next main rod of that member, all the vertical rods are firmly bound in their proper positions according to a regular plan. The rods of the posts were spliced to the rods of the foundations by means of pipe sleeves, while the tie rods at the top of the bin also pass through pipe sleeves, placed in position when the concrete was being poured.

The bin was designed by H. R. Wahl under the supervision of O. M. Bilharz, the gen. mgr. of the Doe Run Lead Co.

Omit taking chances. The odds are against you.

¹Corrugated Bar Co., Buffalo



Concrete Service Poles Withstand Storm

The extreme strength of the reinforced concrete telegraph pole has been demonstrated upon more than one occasion in violent storms, to which poles of the wooden type readily succumb. The most severe test ever inflicted upon them occurred in the blizzard in the East early in March, from which they emerged intact. Perhaps the most striking example of their extreme durability as exemplified in this storm was in the case of the telegraph line of the Pennsylvania R. R. Co., where a large number of reinforced concrete telegraph poles were exposed to the storm which swept over the Hackensack meadows in the vicinity of the west entrance of the Pennsylvania tunnels leading into N. Y. C. The company had erected many of these poles in recognition of their durable and storm-proof properties. As is well known, the storm center was in and about N. Y. C., and so violent was the wind, which reached a velocity of 70 mi. to 80 mi. per hr., and so great the accumulation of snow and ice, that New York was practically isolated for a time, at least so far as above-ground telegraphic communication with Philadelphia was concerned. The company's telegraph line was out of commission for a long time and many of the wooden poles were broken down by the wind and their burden of snow and ice.

In no case, however, did a reinforced concrete pole collapse. So se-

vere was the stress that the wooden cross-arms upon some of these poles were broken, but the poles themselves remained intact. The absence of telegraphic communication cost the company many thousands of dollars, as trains were stalled and in some instances completely lost, at the height of the storm. There was no way for the company to get into communication with the crews. It has been stated that had the entire line been constructed of reinforced concrete poles it would have saved the company a tremendous loss.

As concrete improves with age and exposure to the elements, the poles are constantly gaining in strength and durability. As stated above, they are not only time-proof, but keep in far better alignment than poles of the customary type. They do not rot as do wooden poles and never rust as is the case with steel poles. At the present high price of timber, concrete poles are not prohibitive in first cost, and, considered as a long-time investment, are extremely economical. The Pennsylvania and other railroad companies are establishing their own manufacturing plants and it is likely that the next few years will witness a marked increase in the installation of concrete poles on all important lines.

If you are injured, no matter how little, tell your foreman about it right away, and go to the hospital. A slight injury may cause blood poisoning.

A Further Account of Tests of the Action of Sea Water on Concrete

How sea water affects concrete is an interesting and most important question—a question that needs a more definite answer than any amount of theorizing could develop. In 1909 prisms made of varying kinds of concrete were suspended in the water of Boston harbor. The condition of these prisms has been reported upon from time to time. The following notes are the last report.

[Editors' Note:—At the time these specimens were cast and placed, they were described in the current issues of *Concrete, Concrete Engineering and Cement Age*. A complete detailed report of the inspection of 1910 was published in *Cement Age* for Oct., 1911. From this report the following paragraphs noting the conditions of the specimens at that time, are summarized.]

The examination was made Mar. 3, 1910, about one year after the prisms had been placed in the water. While 24 prisms were reported on at that time, the ones referred to in this present report are the only ones quoted.

CONDITION OF PRISMS MAR. 13, 1910

No. 3. Examination showed this to be apparently in as good condition as when placed.

No. 4. This was found to be slightly pitted on the sides but more so on the front face where the fine material had apparently been eroded, exposing the stones, but these were firmly embedded. The extreme erosion on the front face was about 1".

No. 7. The condition of this specimen was somewhat similar to that of No. 4 but not quite so bad except above high-water.

No. 8. Apparently in as good condition as when placed.

No. 16. Apparently no change from original condition.

No. 17. Same as No. 16.

No. 18. Same as No. 16.

No. 24. In good condition except that the outer face seemed somewhat soft.]

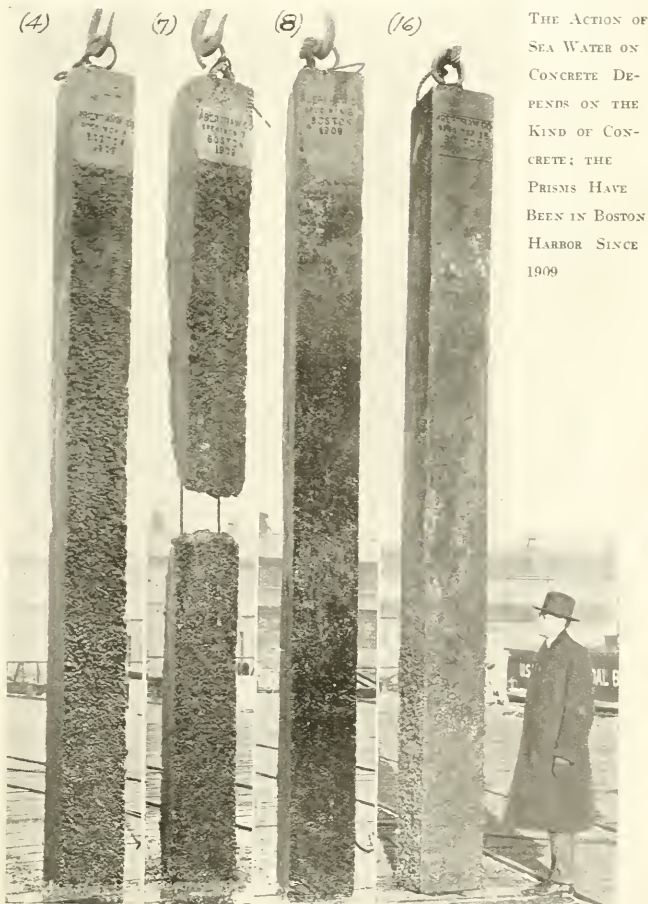
To determine whether chemical action or frost action is more largely responsible for the surface spalling on concrete piers, tests made by the Aberthaw Const. Co., Boston, beginning in 1909, have shown some of the features which enter into the problem. The tests made seem to indicate that with a proper mix and proper care, piers and other struc-

tures can be made to withstand such disintegrating influences. Twenty-four piers, 16' long and 16" x 16" built by the Aberthaw Const. Co. in the Charlestown Navy Yard, have been hung under the cap of one of the piers in that yard for the past five years, being periodically examined for results. The piers were so placed that about 18" was out of the water at high tide and about 41 1/2' was under water at low tide, the mean tide being about 10'.

Recent examination, partially represented by the accompanying views, has been followed by a further immersion in order that the test may

be carried out for several years longer. Enough has been learned, however, to show that certain methods of construction will not give satisfactory results for structures exposed to alternate immersion in the water and exposure to air, particularly when the temperature of the air is far below the freezing point.

In general, it may be said that the richer the specimen in cement, the better does it stand the test. In fact, the one pier of the 24 which was eaten all the way through was one of the leanest specimens tested. This pier is No. 7, and was made of a 1:3:6 concrete, cast quite dry, a total of 182 lbs. of water having been used. This specimen, which was cast in Jan., 1909, and first immersed six or seven weeks later, was examined in Mar., 1910, when it was found to be slightly pitted on the sides—more so on the front face,



THE ACTION OF SEA WATER ON CONCRETE DEPENDS ON THE KIND OF CONCRETE; THE PRISMS HAVE BEEN IN BOSTON HARBOR SINCE 1909

where the fine material had apparently been eroded, exposing the stones but leaving them firmly embedded.

When this specimen was examined and photographed, nearly four years after the previous examination, it was found to be eaten entirely through at about 31 $\frac{1}{2}$ ' above low water. About 1' of the length of the specimen was entirely gone, but the reinforcing bars held the pieces together, as shown. The back side was eaten away on a slant, for a distance of nearly 10' but the specimen was only very slightly affected below the low water line. At the eaten section the material was dead and particles could be picked off the surface with the finger nail.

Specimen No. 8 which also showed considerable action, but was not broken, was made of the same mix of cement and cast plastic by the use of 240 lbs. of water. At the time this specimen was cast moderate tamping showed quaking, with spots of water on the surface. This specimen weighed 146.6 lbs. per cu. ft. of net concrete, as compared with 142.5 lbs. for No. 7.

When this specimen was examined, a year after immersion, it was apparently in as good condition as when placed. At the recent examination, however, the back face was eaten badly for a distance of about 2 ft. between low tide and mean tide, the erosion reaching a depth of 5". A streak was eaten down the center of the back from the high tide mark to the bad spot. The front and sides were somewhat pitted.

As a contrast with these pier samples, specimen No. 3, made from 1:1:2 concrete, and cast very wet by the use of 425 lbs. of water, shows a splendid condition, even after five years of treatment. This specimen when cast was soft enough so that the concrete would run out of an overturned wheelbarrow, but it would not flow like syrup. The net weight of concrete per cu. ft. was 145 lbs.

When examined in Mar., 1910, No. 3 was apparently in as good condition as when placed. At the recent examination the face and back were slightly pitted but the edges and sides were perfectly good and the back showed very slight action.

Practically these same remarks hold for sample No. 16, which has come out of the test so far just as well as No. 3. This was of the same mix as No. 3, except that instead of Portland cement, iron-ore cement was used in the same proportions as before. This sample was mixed less wet than No. 3, only 315 lbs. of water being used. When the pier was leveled off oily streaks showed in the

water on top. The net weight per cu. ft. of concrete was 149.6 lbs.

On the other hand, prism No. 17, of the same materials as No. 16, but using a 1:3:6 concrete with iron-ore cement as in No. 16, showed all four sides slightly eaten from high tide to bottom, most of the action being around the low tide mark. The corners were eaten away to some extent. All of the eating action appears to be on the mortar, the stone being unaffected. This sample stood up better than the average, the deepest holes being less than 1 $\frac{1}{4}$ ". At the same time, the distinction between this and No. 16 bears out the statement that the richer mixes stand the test better.

Experiments were tried on a number of prisms of 1:3:6 concrete in which the cement was varied by the addition of certain ingredients. One sample in which 10% of the weight of cement was replaced by hydrated lime, showed the front face badly pitted from mean water clear to the bottom, being eaten to a depth of 4" at the middle. Edges around the middle were soft and dead; the sides and back were pitted.

Another sample in which the cement was prepared with Sylvester solution of soap and alum, showed somewhat similar results. The face was badly eaten above the low-water mark and all four edges and the back were eaten away; the corners at the bottom were gone, and all faces of the specimen slightly pitted.

As a distinction from the last two, sample No. 24 was mixed with 5% of pulverized clay in the cement. When examined this showed a very good condition above the water line, though the surfaces between high and low tide were somewhat eaten and the corners were rounded off all the way from high water to the bottom. The four faces of this specimen, however, are still in pretty good condition.

All of these specimens were reinforced with a 5 $\frac{1}{8}$ -in. twisted square steel bar bent into a loop and inserted for the full length of the specimen near two opposite corners. The stone used was a broken trap rock weighing 90 $\frac{1}{4}$ lbs. per cu. ft. and passing a 1 $\frac{1}{4}$ -in. ring. The sand was clean, sharp and fine, weighing 97.2 lbs. per cu. ft. when dry. It contained 4.6% of moisture when used.

The illustration is from photographs which have not been retouched. The piers were not scraped and in some cases small barnacles adhering to the lower ends produce an appearance of roughness not justified

by the specimens themselves. Many barnacles which jarred loose when the piers were set down upon the wharf will be noticed scattered about.

Very complete tests were made of the cement and other materials used. Nothing out of the ordinary was noticed in the cement tests except for the very long time (26 hrs.) taken by the iron-ore cement in getting a hard set. This is interesting as showing the effect on the set of the almost total absence of alumina. The use of hydrated lime gave a very quick set, but although the initial set was very rapid, the paste was easily worked to a soft mix for several hours afterwards. The voids in the sand measured 34.2%; 4.8% of the sand by weight passed a No. 100 screen, and 9.1% a No. 10 screen. The stone contained 50% of voids; 53% of it passed a 3 $\frac{3}{4}$ -in. ring.



DETAIL OF ENTRANCE IN CONCRETE UNITS

Concrete Stone Used Effectively With Red Brick

The accompanying illustration shows interesting detail of a residence on the O. C. Barber estate, Barberton, O. The trim was made in the concrete department of the Barber enterprises; semi-wet, tamp method with a light, cement-sand facing. The straight block work was turned out of Ideal machines and the other work from special molds. The concrete trim makes a good contrast with the red brick.

¹Ideal Concrete Machy. Co., Cincinnati

Concrete for Hot Well in Factory Construction

In all well organized mills, especially paper mills, the saving of hot water and exhaust steam amounts to quite an item on the yearly coal bill. At the Great Northern Paper Co.'s mill, Madison, Me., a cast iron well had long been used for receiving the drip from paper machines and various lines where steam was used. Whether through settlement of foundations or long continued use the iron cracked and the escape of steam and water became a nuisance. It was practically impossible to install another iron well, as the basement was too full of machinery and the walls were too thick for cutting to allow its passage. It was then decided to try the experiment of a concrete hot well.

The interior dimensions of the well were 12' long x 8' wide x 5' deep. Walls were 6" thick and roof 4 1/2". The walls and roof were reinforced with 1/2-in. twisted square bars laid so as to form a complete steel cage. The interior forms were well braced and made a sealed box, around which was placed the reinforcement. This interior box was supported on brick and wired and stayed to the outside forms so that placing of concrete would not disturb it.

PRECAUTIONS FOR WATERPROOFING CONCRETE

In order to make a waterproof concrete, experiments were made with different proportions of crushed rock

and sand to get the mixture with the fewest voids and get at the same time as much rock as possible. Permeability, of course, is relative to density, but, in the writer's opinion, a denser concrete is produced by using the highest proportion of crushed rock possible, retaining, of course, the necessary amount of binding material. After determining, with different amounts of 2-in., 3/4-in. and "pea" rock, a normal concrete, more cement was used than would ordinarily be considered necessary in order to fill all voids in the sand and have a slight excess of cement.

The concrete was poured in one operation to avoid cleavage lines. This made a rough bottom inside, which was troweled to floor finish after the inside forms were removed. A gang of seven laborers mixed all material by hand and two extra turnings were given. Cement and sand were made into a mortar and the rock dumped on this and turned 15 times.

A wet mixture was used and was constantly puddled to remove all air bubbles. This puddling is very important and if neglected is the cause of porosity in concrete which otherwise is perfect. The forms were removed after 3 das. and a smooth, glassy surface was presented outside and in.

To condense whatever steam entered, a dome was built and in the dome four bronze rods carried tilted plates of brass perforated with 1/8-in. holes. Cold water flowing over the plates condensed all steam. The cold water supply was governed by a float valve not shown in sketch. The dome was provided with a relief pipe and the tank could be entered for inspection purposes through a top manhole.

After the tank was put into operation fine hair cracks developed on the sides, which caused the concrete to sweat. After a week's time, however, a white efflorescence appeared in each crack, completely sealing the pores. No other cracks showed up, although the temperature was at times as high as 180° F.

The location of the tank and the difficulty of getting materials to the site through lines of shafting increased the costs above what they would have been if the tank had been in the open. The work required 17 cu. yds. of concrete. Carpenter labor cost \$2.50 per day of 9 hrs., common labor \$1.75. The total cost of the tank, including form lumber, carpenter labor, concrete labor and materials, was about \$255, or \$15 per cu. yd.

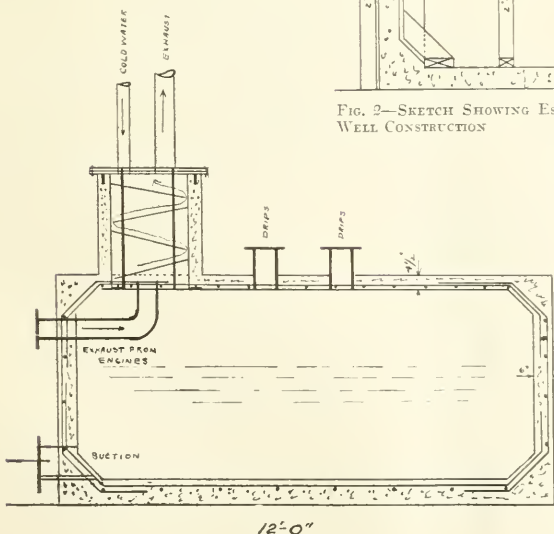


FIG. 1—SKETCHES SHOWING ARRANGEMENT OF PIPES AND DOME IN A CONCRETE HOT WELL

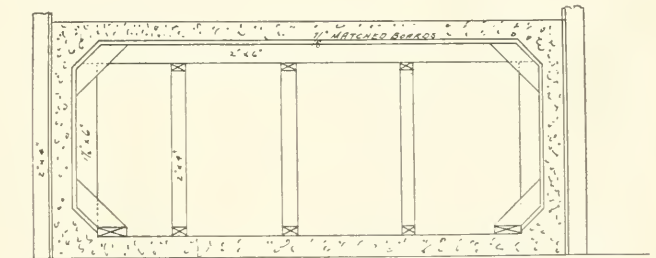


FIG. 2—SKETCH SHOWING ESSENTIAL FEATURES OF CENTERING ARRANGEMENT IN HOT WELL CONSTRUCTION

Details of a Home-Made Mixer and Elevator and Their Operation

"Necessity is the mother of invention" is an old saying. The following notes and sketches illustrate a recent application. Doing away with

The sand, aggregate and cement were mixed dry in the power mixer and dumped into the hand-mixing box, which was so placed as to elimi-

of a belt pulley *H* on the engine, which was connected by a belt with the larger grooved pulley *I* on the end of a windlass. The windlass and grooved pulley were on a frame *A* built of 2 x 4's and hinged to the platform which held engine, mower wheels and mixer. One end of hoist rope was wound around the windlass, the cable carried through block *J* and down near mixing box, and equipped with a hook at the end, to which the pail was attached. Rope *K*, when taut, kept frame *A* in an upright position, which in turn pulled belt *L* tight and turned the pulley *I* and wound rope around windlass, pulling pail of cement to top of silo. When the pail is up to the required height and swung onto the platform, the drum is stopped by slacking up on rope *K*, which allows the weight on arm of frame *A* to pull the frame back by letting belt *L* slide around on pulley *I*.

When the empty pail was placed

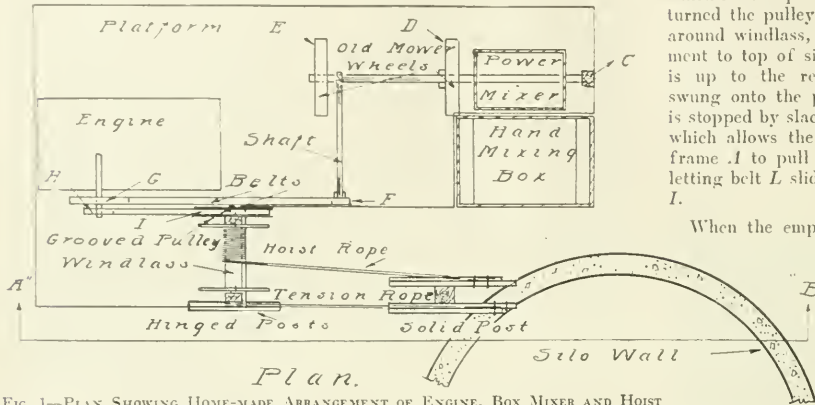


FIG. 1—PLAN SHOWING HOME-MADE ARRANGEMENT OF ENGINE, BOX MIXER AND HOIST

a clutch, controlling the operation by moving the entire drum and having the hoist controlled from up on the work are interesting for ingenuity shown, if for nothing else. Silo work is described but the same problems are faced on many a house-building job.

H. L. Chapman, Marcellus, Mich., while erecting a concrete silo last summer used an outfit made from old equipment he had lying around. The work with this rig was cheaper and quicker than mixing and elevating the material by hand.

The mixer consisted of a box about 18" x 18" x 36" with one side removable to permit loading and unloading; a lid was clamped in place while machine was running. This box was swung on a shaft which had a rigid bearing, as shown by *C* of the accompanying sketch, the other end of shaft being fastened to one wheel *D*, of an old mower carriage. The other wheel *E* was blocked up and fastened to the platform to allow the wheel *D* to revolve. A belt from the engine pulley *G* was run over the pulley *F* which was on the shaft which transmits the power from wheels to knives in a mower.

nate shoveling out of mixer. In this hand-mixing box, water was added and the final met mix made.

The elevating machinery consisted

on hook, it was heavy enough to unwind the rope on the windlass and run it to the ground, where it was refilled by a man at the mixing box.

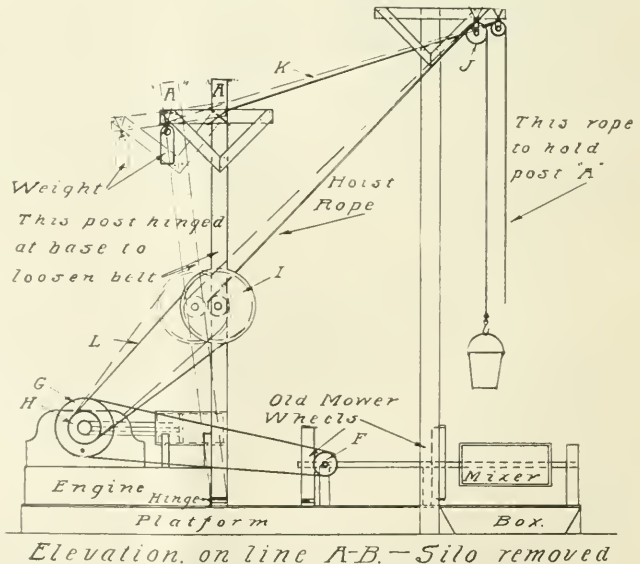


FIG. 2—ELEVATION OF SIMPLE MIXING AND HOISTING EQUIPMENT

The hoisting drum, or windlass, is mounted on a movable hinged frame

Details of a Self-Supporting Unit Wall Form of Metal-Faced Wood

The last few years have seen many interesting developments in form construction, and in the accompanying sketches details of a unit form developed and used by P. H. Bosworth, San Francisco, are shown.

This form is a sectional unit of any required size and is made of all wood with a metal face. A wide stud, 2" x 10" or 2" x 12", is used, a feature which gives the form strength and stability, and makes it practically self-supporting and self-aligning without adding appreciably to the weight or the bulk. The height is either 2' or 3'; the length of one unit is usually 2'. These solid studs form the ends and partitions of each unit: 1-in. x 4-in. ledgers or rails are nailed on the top and the bottom and a 1 in. x 6 in. T. & G. material forms a smooth face. Once leveled the forms build up from the ground plumb and true without any further attention; a shim here and there at intervals is all that is needed to bring them to an exact level. Tapered wedges driven between the horizontal rails, as shown, lock them together and align perfectly the faces of the new and the old forms.

The forms being all wood, strips can be nailed to them wherever necessary for separating and bracing. Wires are run from form to form through the wall to hold the forms in place. Light strips are nailed across the forms to hold the boxes in place. After pouring, these strips are removed to allow the placing of the next tier of forms.

The outside forms follow each other end to end around the building, except where large openings occur, when one or more units can be omitted if desired.

The inside forms must be separated at one place on each side of each room. This space can be anything from 6" to 2', depending on the size of the room and the length of the forms used. This space is filled in with T. & G. similar to the face of the form by nailing strips vertically to the ends of the forms and tacking the T. & G. boards in place. This precaution is necessary, as in taking out the forms after the walls are set this filling piece is first torn out, when the forms can very easily be worked loose.

The inside corners are made by placing the end of one unit against

the side of the other or by bringing the inside or near corners of two forms together, placing a piece on an angle between the two outside or far corners and tacking it in place. This makes a heavy angle corner in the room and reinforces the corner with additional concrete.

The solid floor slabs are formed by placing vertical joists from form to form and tacking down a T. & G. floor on top of them, then placing reinforcement and concrete. The hollow floor slabs are made by placing flat joists from form to form, upon which are placed the metal linings and the reinforcement, over which the concrete is then poured.

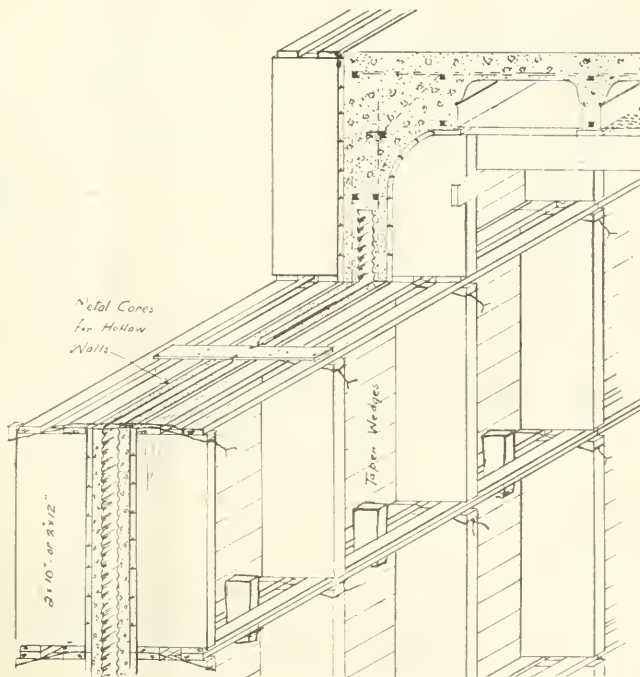
The metal linings are of two kinds, one-half and whole. The half-linings come away, leaving a corrugated paneled ceiling; the whole linings stay in the floor, having an expanded bottom upon which the plastering for the ceiling is directly applied.

The hollow walls are formed by placing the corrugated metal linings between the forms around which the

concrete is poured. The linings are made of the lightest block iron in sections of approximately 24" x 24" and are stamped out to give any thickness of air space desired. The edges of half-linings are doubled over to form a groove into which the straight edges of the other half slide, locking both halves together. The space between the two halves of the lining form the resultant air space in the wall. They are held in place in the walls by the same strip that separates the forms and the space thus left between the two metal linings where this strip comes fills with concrete, forming a solid rib or stud approximately 1" wide every 2' of wall.

This system of forms and the metal cores have been patented by Mr. Bosworth, but so far there has been no general development of them, although Mr. Bosworth has used them extensively on his own work. Correspondence relative to more detailed information on these forms and their use will be welcomed by Mr. Bosworth.

"You can lead a horse to water, but you cannot make him drink" means that you can show some people dangerous places, but you cannot persuade them to be careful.



SKETCH IN PERSPECTIVE, SHOWING ARRANGEMENT OF SELF-ALIGNING WALL UNITS

Recent Inventions in the Concrete Field — Some Details from the Patent Office

By LESTER L. SARGENT

A fireproof stair that is sufficiently light to be easily handled, although composed almost entirely of concrete, has been invented by Francis A. Winslow, Chicago. Each stair unit consists of a step portion and riser,

factors are to be considered by those having to do with the molding, transporting or assembling of concrete stairs.

APPLYING INSET TILE DECORATION

A novel and easy method of constructing mosaics, ornamental brick mantels, tile hearths and fireplaces,

whatever design or arrangement has been selected. Cement or plaster is then poured over the back of and between the tiles and allowed to set. When the finished article is hardened it is removed from the mold, the sugar coating on the face of the tiles or mosaics is washed off with water and in this simple manner the work is completed. The coating of syrup, spread over the mold on which the tiles are arranged, fills and seals the bottoms of the interstices between the tiles as laid, allowing the cement or other plastic composition when poured over the tiles to fill the interstices down to the composition coating, which prevents the cement from working under the tiles and injuring

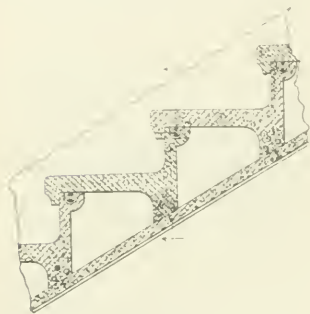


FIG. 1—A SUGGESTED STAIR UNIT WITH INTERESTING POSSIBILITIES

formed together, and of substantially L-shape in cross-section. The outer edge of the step portion is, however, provided with a nosing that projects down and engages over the top of the riser portion of the stair unit immediately beneath. Consequently, the joint between successive steps will be invisible, with the result that a stair of appearance sufficiently attractive to satisfy the most aesthetic taste is obtained. In order to counteract any tendency of stair units to crack longitudinally under strain, reinforcing rods in the form of truss bars are disposed in a downwardly extending part of each riser. In the widened upper edge of each riser is a groove in which lies a tie-rod that is secured to the side plates of the stair. The stair units are uniform in size, shape and appearance and of relatively light weight—all of which

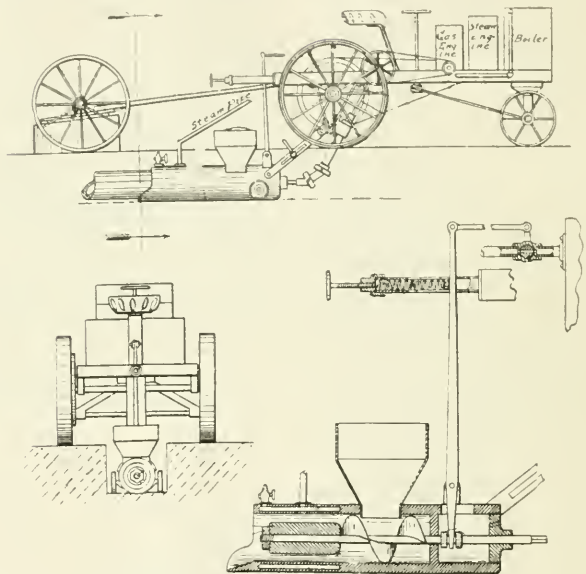


FIG. 3—A PORTABLE MACHINE TO MAKE CONCRETE TILE IN PLACE

and tile floors and walls has been devised by Franklin P. Nale, Birmingham, Ala. First, he coats the top face of the bottom of the mold upon which the mosaic or the design of tiles is to be set up with a paste or syrup made of glucose, sugar or cane syrup, spreading it thinly over the mold or platen with a brush. Then the tiles are set, with face down, in

the face. With this method it is feasible to employ a mold with a transparent glass bottom, through which the design can be inspected—since the sugar coating is also transparent—to make sure of the correct positioning of the tiles or mosaics, before the cement is finally poured into the mold to bind the whole design together. A soft, non-cementitious coating for the mold is an essential feature of the method. An oily composition is undesirable, since it may discolor the cement or plaster between the tiles, as well as affect the tiles themselves. The syrup or sugar, on the other hand, can be readily washed off, may be recovered if desired, and so thin a coating is required that the cost of coating the mold is negligible in any event. E.

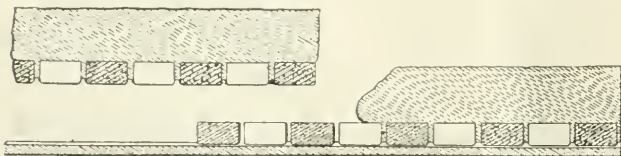


FIG. 2—DETAIL SHOWING METHOD OF ARRANGING INSET TILE FOR DECORATING CONCRETE SURFACES

¹Washington, D. C.

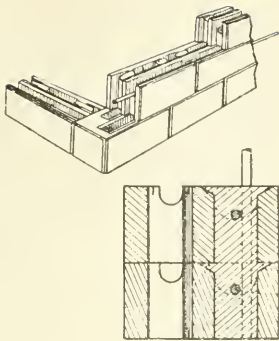


FIG. 4—A TRIPLE-WALLED CONCRETE BLOCK DEVELOPS CONTINUOUS AIR SPACE AND A SOLID WALL

J. Hudnall, Birmingham, Ala., has acquired a half interest in the patent rights.

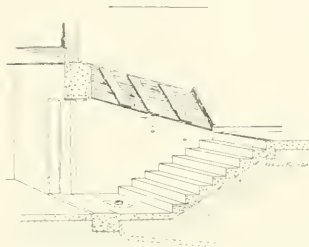
MAKING CONCRETE PIPE IN PLACE

A machine for making concrete pipe in place, and doing so with considerable speed, has been invented by Howard E. Marsh, Palms, Cal. A tubular casing is provided which contains a core-forming body, in advance of which is a spiral blade positioned beneath a hopper, through which the plastic concrete is fed to the spiral, which forces the material to the rear around the core body to form the pipe in its original position as the machine progresses. To state the matter more explicitly, the pipe-forming mechanism is trailed along by a motor-driven vehicle and the concrete pipe is thus expeditiously made and laid. The speed of the vehicle is automatically regulated. Back pressure of the plastic material on the spiral blade in the tubular casing effects this result, for the shaft on which the spiral blade and the core-forming body or cylinder are mounted is connected by regulating levers with the throttle of the engine. Another feature of the invention is an annular chamber formed in the wall of the tubular casing at the part of the casing within which the core-forming body operates, so that steam may be introduced into this annular chamber and the exterior of the newly-made pipe heated. In this way a thin crust is formed and collapse of the pipe when laid is prevented. The entire wall of the pipe is not, however, hardened by the steam, the vehicle being propelled at a sufficient speed to prevent this. But it does prevent collapse of the pipe while still in a moist condition, which is the object sought.

CONCRETE BLOCK DEVELOPMENT

A building block of some interest to concrete men has been recently

patented. This is a concrete block having a longitudinal partition dividing the block centrally to form two openings or hollow portions. When the block are laid in a wall, concrete is poured into the outer cells, uniting the wall into a homogeneous slab. The inner half of the blocks is left unfilled, thereby producing an air space or passage for the circulation of air vertically and transversely of the blocks, eliminating to a great extent the presence of moisture in the inner face portion of the blocks, and keeping the wall comparatively free from dampness. The transverse or connecting end portions of the inner half of each block are hollowed out on top longitudinally of the block to provide for the air circulation mentioned.



CONSTRUCTION OF CELLAR STEPS OF CONCRETE

Concrete Steps and Walls for Cellarways

A damp cellar under a dwelling is frequently the unsuspected cause of many a case of sickness. Often this dampness is the fault of a poorly built entrance-way. If water gains access by means of leaky hatchway walls, the cellar becomes unsanitary and the health of the entire family is endangered. This danger can be dispelled by making the walls and steps of concrete.

The methods of building hatchways for either new or old cellars are very similar. With an allowance for a 3-ft. landing at the bottom of the stairs, excavate the opening to the width of steps desired plus 1'. This extra width is for a 6-in. thickness of concrete wall on either side. The steps themselves have a rise of 6" and a tread of 9". Beneath the steps proper is a 4-in. thickness of concrete. Therefore provide for this thickness in sloping the ground upward from the landing to the top of the stairs. Extend the trenches for the side and the end walls 1' below the concrete of the steps. As forms choose two boards 1" x 12" and notch them as though they were to be used

as "horses" to support wooden steps of the same dimensions as those of concrete. Place the notched edges down with the ends fixed at the top and the bottom of the stairs. To mold the risers of the concrete steps, use boards 1" x 6", 3' 10" long, which are secured to the forms by means of nails and wooden cleats.

With the forms firmly fixed in position, fill the mold for the bottom step, and the space back of it with concrete proportioned 1 bag of Portland cement to 2 cu. ft. of sand to 4 cu. ft. of crushed rock. If bank gravel is used, mix the concrete 1 part cement to 4 parts gravel. Bring the concrete in each step to the top of the riser and finish the surface with merely a wooden float. Continue the work upward until all the steps are finished. At the top of the stairs tie the apron foundation to the side walls by means of old iron rods embedded in the concrete and extending around the corners. This will prevent possible heaving and cracking from frost.

The side forms of the 6-in. walls are then erected and are thoroughly cross-braced against each other. For these forms use 1-in. siding on 2-in. x 1-in. studding spaced 2' apart. The walls can be carried to any height desired so as to give the cellar doors sufficient slope for shedding rain-water. Above ground line, outside forms must be provided. Fill the walls with concrete mushy wet. Before the concrete sets, bolts are placed (heads down and washered) in the tops of the side walls for holding the wooden sills to which the cellar doors are hinged. After two to four days the forms can be removed. Connect up the drain in the landing and lay the landing floor.

The eight cellar steps of the hatchway shown in the plan have a tread of 9", a rise of 6" and a length of 4'. The clear height of the doorway in the cellar wall is 6' 6". The landing at the foot of the steps is 3' x 4' and has a 4" concrete floor. This same thickness of concrete lies under the steps proper. The side walls are built as described above. For this improvement there are required the following quantities of materials:

Bill of Materials

Crushed rock	2½ cu. yds.
Sand	1¼ cu. yds.
Portland cement	12 bags

For improving old cellar hatchways it is frequently necessary to fill with earth and gravel so as to provide the earthen slope for the concrete steps. Such filling must be thoroughly tamped into place and should be water-soaked and allowed to settle before the steps are built.

¹Description supplied by Assn. of Am. Portland Cement Mfrs.

Materials and Methods Used in the Manufacture of Concrete Sewer Pipe¹

By W. B. DUNNING²

Cement was first used for sewers in the construction of the cloaca maxima or great sewer of Rome about 700 B. C. and this sewer is still in service today, after a period of 2,500 years. Cement was also used in the famous aqueducts which still bring water to the ancient city.

In 1850 Paris began constructing sewers of concrete and by 1870 had 30 miles in service. Finding this form of construction entirely satisfactory, its use has been continued, until today there are between 200 miles and 300 miles of concrete sewers in Paris. Vienna also uses concrete sewers almost exclusively.

Cement was first used in this country in the form of pipe in the '60's by Brooklyn, N. Y., Providence, R. I., and Paterson, N. J. Most of this pipe was made from natural cement, and although inferior to that made from Portland cement, gave fairly satisfactory results, and some of it is still in use.

The following paragraphs will point out the application to making concrete sewer pipe of those laws which must be observed in the successful use of Portland cement in any structure in which strength, impermeability and resistance to the destructive agencies of Nature and the elements are a prime requisite—in short to make good concrete.

E. S. Wallace, cement insp., Kansas City, stated before the Illinois Soc. of Engineers and Surveyors³: "Our tests have shown conclusively that there are three things essential to the manufacture of good concrete pipe. First, the pipe must be composed of proper materials, second, it must be made right, and third, it must be cured right."

The writer will endeavor to explain what is meant by using proper materials and making and curing concrete sewer pipe right. The use of concrete in sewer pipe is neither new nor does it involve great technique made in lengths of from 2' to 3' inside the bell, of hub and spigot

cal difficulties. The wide variance in the opinions of engineers regarding good practice in the manufacture of concrete sewer pipe is probably due to the fact that the experience of most engineers with concrete sewer pipe has begun with the delivering of the pipe at the ditch side.

Machine-made concrete sewer pipe pattern, the depth of bell varying from 2" to 4". The thickness of the pipe wall is usually made from $\frac{1}{10}$ to $\frac{1}{12}$ the inside diameter of the pipe. Concrete is mixed to a stiff consistency and the pipe are formed in a machine which compacts the concrete inside an outer casing. The compacting and coring devices are withdrawn from inside the pipe and the outer casing and the pipe are removed from the machine. The pipe are transported to curing rooms, where the outer casing is stripped from the pipe and returned to the machine. Pipe are not reinforced. After curing and hardening sufficiently to permit handling the pipe are transported to the yard, where the hardening process continues until they may be used.

Experience has shown that clean aggregate, which most commonly means freedom from clay, loam or crusher dust, means more in saving to the manufacturer of concrete sewer pipe than in almost any other use of concrete. The cost of manufacture, including operation, labor and overhead charge, found from an analysis of cost data from a representative factory amounts to from 40% to 60% of the total cost of the pipe in the yard, depending upon the size of the pipe. Aside from all considerations of quality, it will be found more economical to use none but the best of materials on account of the great saving in the manufacturing process. Pipe which are lost in stripping the jackets due to the fact that clay in the sand used causes the mixture to stick to the jackets to such an extent as to prevent stripping them without destroying the pipe, cost the manufacturer practically as much as if the finished pipe were broken in the yard.

AGGREGATES

The writer believes that no compromise should be made in this mat-

ter of materials. The requirement that aggregates shall meet proper specifications is quite as important as that the cement shall meet the standard specifications. That different kinds of aggregate may be used, is true, however, and in the absence of recognized standard specifications for aggregates for use in concrete sewer pipe manufacture it is believed that facts concerning the selection and combination of aggregates are of interest.

There are two cases to be considered: (1) Where gravel is available. (2) Where sand and crushed stone are available.

When gravel from a bank or other deposit is supplied to the pipe factory without preliminary treatment samples should be examined to determine the cleanness and the grading of the sand and gravel particles.

It has been found that when sand, being material smaller than $\frac{1}{4}$ " in size of particles, contains more than 3% by weight of fine particles ordinarily classed as silt, and usually composed of clay, this material affects the consistency, the stickiness and the working qualities of concrete used in making pipe by machinery and where the aggregate contains 50% or more of sand it affects it to such an extent as to interfere seriously with the value of the sand in making pipe. It is not advisable to make pipe of mixtures containing a greater amount of aggregate smaller than $\frac{1}{4}$ " in size than 2 parts to 1 part of cement. Leaner mixtures possessing the requisite strength and impermeability for use in sewer pipe are made by the addition of aggregate larger than $\frac{1}{4}$ " in size.

Tests may be made by selecting representative samples from the gravel as received and screening out the sand through a No. 4 sieve.

Sand when supplied free from particles larger than $\frac{1}{4}$ " in size may be examined in the same manner as screenings from gravel.

The silt test described in Bulletin No. 329, U. S. Geological Survey, (Organization Equipment and Operation of Structural Materials, Testing Laboratory, St. Louis, Mo., 1908, p. 28) is easily made and gives accurate results. It is recommended that apparatus for conducting this test be set up and that frequent examinations of aggregate be made.

PERCENTAGE OF SILT

Apparatus—The apparatus used in this determination is shown in Fig. 1. The glass percolator (a) is 13" long, with an upper inside diameter of 3", and a lower inside diameter of 2½". The vessel (b) is placed with its outlet (c) 3" above the top of the percolator. The opening (d) at the bottom of the percolator is ½" in

¹Paper presented before the Am. Cement Pipe Assn., Feb. 19, 1914

²Asst. Engr., Universal Portland Cement Co., Chicago

³Use of Concrete Sewer Pipe in Kansas City, Mo., paper before Illinois Society of Engineers and Surveyors, Jan. 30, 1914

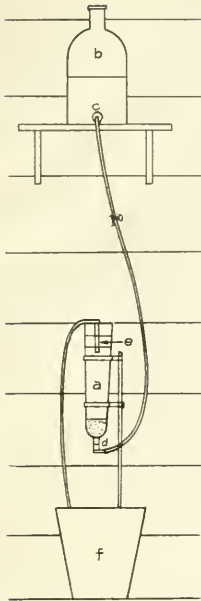


FIG. 1

diameter, and is fitted with a perforated porcelain disk to prevent the passage of the material placed in the vessel. The glass tube (e) is placed with its lower end 10" above the surface of the material.

Method—The vessel (b) and the percolator (a) are filled with clean water, and a 100-gram to a 200-gram sample, depending upon the probable amount of silt present, is put in the latter. The upper stopper of the percolator is put in place, and the current of water is started. The silt is carried by the current of water over into the vessel (f). The flow of water is continued until the effluent is clear, when the upper stopper is removed, the material stirred, and the current again started. This operation is repeated until the effluent is clear immediately after the material is stirred. The water containing the silt is evaporated on a water-bath, when the silt is scraped and brushed onto a watch-glass and permitted to remain uncovered until it attains the temperature of the room so that it will be under the same conditions as the original sample. It is then weighed.

Computations—The percentage of silt is the weight of the silt, divided by the weight of the material placed in the percolator and multiplied by 100.

When the available sand contains silt as thus determined in excess of 3% in any samples representative of the material to be used, washing will be found economical. Silt in any amount is objectionable from a manufacturer's viewpoint.

REMOVE STONE DUST

Crushed stone or crushed gravel should be examined for dust. A convenient and practical method of removing the dust from crushed stone, where material is crushed in the

plant, is to allow the crusher-run material to pass over an inclined screen about 5' long and having openings about $\frac{1}{16}$ " in diameter. It will be found that very little material larger in size than that passing a No. 40 sieve will be removed by this screening, most of the material removed being fine dust.

The remarks concerning silt in sand apply to dust in crushed stone and the method used in determining silt may be applied to dust in crushed stone. If the crushed stone as supplied is not satisfactory it should be cleaned of dust before being brought into the pipe factory. Dust in crushed stone screenings is very difficult to remove after the screenings have become wet. Washing is the only method which may be relied upon in this case.

Gravel and crushed stone up to $\frac{1}{2}$ " in size have been used successfully in the manufacture of all sizes of concrete sewer pipe.

It is not practicable for the purpose here intended to screen damp gravel through stationary inclined screens or small rotary screens. Fine material clogs up the openings in the screen and the screening process becomes very inefficient. The resulting variation in the grading of the aggregate with different conditions of dampness in the sand means a serious inconvenience and loss to the manufacturer. It is recommended that one of two methods be used in the screening of the sand, the method to be selected depending upon the necessity of washing to remove objectionable amounts of silt.

(1) Screening through a screen having $\frac{1}{4}$ -in. holes, the sand being carried through with a large amount of water and the silt being carried away by means of a sand-settling box, from which clean sand is removed from the bottom while the silt goes over the top with the water.

(2) By the use of shaking screens.

When the material supplied to the pipe factory is gravel a crusher should be installed in order to use the pebbles rejected by the $\frac{1}{2}$ -in. screen. The aggregate as prepared for use will then include the following grades of material:

(1) Sand, being screenings from gravel, all passing a screen having openings $\frac{1}{4}$ " in diameter.

(2) Crushed gravel screenings all passing a screen having openings $\frac{1}{4}$ " in diameter.

(3) A mixture of screened gravel and screened crushed gravel retained on a screen having $\frac{1}{4}$ -in. openings and passing a screen having $\frac{1}{2}$ -in. openings.

When the material supplied is sand and crushed stone, the prepared material should be separated so as to provide:

(1) Sand.

(2) Crushed stone screenings, passing a screen having openings $\frac{1}{4}$ " in diameter.

(3) Crushed stone retained on a screen having openings $\frac{1}{4}$ " in diameter and passing a screen having openings $\frac{1}{2}$ " in diameter.

The material under 2 in this case may be omitted in case the material as supplied is free from screenings.

In case the sand, or sand and stone screenings is deficient in fine material, a fourth class of material, being a fine sand can be used in order to supply this deficiency in graded fine material. The grading of the sand is vital to the making of smooth pipe which can be turned out economically. The silt test may be relied upon to detect objectionable amounts of extremely fine particles in this fourth class of material.

GRADING OF AGGREGATES

The combination of the aggregates will now be discussed, these remarks applying to either case where sand and crushed stone or sand and gravel screenings are used. The classic experiments of Sanford E. Thompson and his conclusions regarding the effect of the grading of aggregates upon the strength and density of concrete afford a foundation for the recommendations which are made herewith, together with a large number of analyses which have been made in the laboratory of the Universal Portland Cement Co. of aggregates used in the manufacture of concrete pipe and tile and the experience of manufacturers with the materials tested.

The writer believes that the aggregate should preferably be uniformly graded in sizes of particles from those passing a No. 10 sieve up to the largest size used. By uniformly graded is meant that the percentage of particles which is retained on a sieve having openings $\frac{1}{10}$ " in diameter and which passes a sieve having openings $\frac{7}{10}$ " in diameter, shall be the same as the amount retained on a sieve having openings $\frac{1}{5}$ " in diameter and passing a sieve having openings $\frac{3}{10}$ " in diameter, and so on up to the largest sized particles. It is not necessary, however, to separate the aggregates into more than those sizes indicated in the foregoing remarks to insure satisfactory grading.

The grading of that part of the aggregate passing a No. 10 sieve should not vary considerably regardless of the maximum size of the ag-

gregate used, that is, whether the largest sized particles are $1\frac{1}{4}$ " or 1" in diameter.

The writer considers an aggregate having a maximum size of particles of $1\frac{1}{2}$ ", of which 20% passes a No. 40 sieve, 30% passes a No. 30 sieve, 40% passes a No. 20 sieve and 50% passes a No. 10 sieve, as well graded in the smaller sizes. If uniformly graded from the No. 10 sieve up to the maximum size of particles, an aggregate having a maximum size of particles of $1\frac{1}{2}$ " would then contain 18% of the material retained on a No. 10 sieve and passing a No. 4 sieve and 32% of material retained on a No. 4 sieve and passing a $1\frac{1}{2}$ -in. sieve. The grading of the aggregate larger than that passing the No. 10 is not of vital importance, its amount being the variable to be carefully controlled. The relative grading of that part of the aggregate passing the No. 10 sieve with particular reference to the amount of material passing the No. 40 sieve is of prime importance and is deserving of careful observation and the taking of whatever precautions may be found necessary to control it.

Aggregates having a maximum size of particles of $1\frac{1}{2}$ " and grading varying within the limits shown in the following tabulation have been used in experiments to determine the most suitable grading and as adopted mixtures in the manufacture of machine-made concrete sewer pipe.

Sieve No.	Per Cent of Aggregate Passing	
	From	To
2	100	100
4	50	91
10	37	68
20	25	47
30	19	33
50	7	13

A deficiency of fine material causes difficulty in the manufacturing process, loss of pipe when pipe are removed from the jacket, rough pipe, stone pockets and pin-holes through which water spurts when pressure tests are applied. A deficiency in fine material within the limits given in the table above does not decrease strength.

An excess of fine material causes loss of strength and with ordinary mixtures tends to produce a pipe which will show seepage under internal pressure tests.

The tendency to use an excess of fine material in the aggregate is to be particularly guarded against because unless pipe are tested the manufacturer may be deceived as to the quality of pipe which he is producing owing to the smooth, and, to the uninitiated, workmanlike appearance of the pipe in which aggregate con-

taining an excess of fine material has been used.

The writer has not mentioned anything about the grading of material passing sieves smaller than No. 40. It is believed that the standard tests for silt, as referred to above, will develop all clay, loam and dust, and that the size of the sand particles which are not removed in this washing test and shown as percentage of silt, will be found in all ordinary materials to meet the requirement that not more than 3% of total aggregate shall pass a No. 100 sieve.

Regarding the mineralogical composition of the aggregate, the best aggregate is composed of siliceous particles. This means that the grains are either quartz or rock high in silica. In no case should aggregate used consist of particles of rock which is subject to disintegration upon exposure to the most extreme range of atmospheric temperature together with alternate wetting and drying, or which is affected by dilute acids or strong alkalis. Special strength tests on mortar and concrete in which the sand and coarse aggregate have been used can alone be relied upon to determine the strength of aggregates.

MIXTURE

For machine-made concrete sewer pipe, the writer recommends a mixture of 1 sack cement to $2\frac{1}{2}$ cu. ft. of aggregate, measured as loosely thrown dry into a measuring box. It is to be noted that when the aggregate is composed of different grades of materials, the mixed combined aggregate will occupy less volume than the sum of the volumes of its components.

The amount of water used in the concrete mixture is of as much importance in the manufacture of concrete sewer pipe as any other one item. Sufficient water should be used in the concrete mixture to permit the thorough hardening of the concrete. This means that all water required by the cement must be supplied in the concrete mixer. Concrete which is mixed to proper consistency and which, in hardening, has not lost water through evaporation, is practically non-absorptive and quite impervious. Several tests made by the writer on fragments of concrete sewer pipe, so made, show less than 3% absorption by weight of water on fragments dried at room temperature and immersed in water for from 24 hrs. to 48 hrs.

Sand practically always contains moisture. Damp sand taken from a bank may ordinarily contain 5% by weight of moisture; thus a cu. ft. of

good concrete sand weighing 94 lbs. when loosely thrown into a measuring box, has been found to contain 5% or 4.7 lbs. of moisture, and 89.3 lbs. of sand. Gravel and crushed stone may be assumed to contain less than 1% of moisture if in an ordinarily dry condition.

Tests made by the writer at Saginaw, Mich., in July, 1913, concrete mixture 1 part cement to $2\frac{1}{2}$ parts sand and crushed gravel, gave the following results: 8.5% of water by weight of the cement and aggregate, found in all cases to be insufficient to produce the desired consistency; 8.8% to 9% of water produced concrete of the desired consistency; 9% to 10.2% of water produced concrete too wet to allow the removal of the pipe from the molds. Sand used contained a considerable amount of silt.

The following data are from reports of tests made on California glazed cement pipe, San Diego, Cal. Concrete mixture, 1 part cement to 2 parts sand; water 10.25% to 10.5% by weight of cement and sand used to produce concrete of proper consistency for good pipe.

Concrete mixture, 1 part cement to 3 parts aggregate; aggregate composed of sand and crushed rock graded up to $\frac{3}{4}$ " in size; 10.5% to 11% of water by weight of total dry materials required to produce concrete of proper consistency for good pipe.

In all the examples given the amount of water contained in the sand is included in the percentage stated. This determination should be made by weighing a sample of sand as taken from the bin; drying it at a temperature of 212° F., until it shows no further loss in weight, and re-weighing. The loss in weight is the amount of water contained in the material. A determination of the actual amount of water required to make concrete of proper consistency for good pipe and measurement of this quantity in a tank with a glass gauge and a suitable marker are recommended. Working conditions determine the exact consistency to be used. The fact that it is usually possible to handle concrete containing an insufficient amount of water as readily as concrete containing sufficient water, and more readily than concrete containing an excess of water, makes it especially desirable to use automatic measuring devices for the water added to each batch.

Pipe made according to ordinary processes should show web marks on the outer surface, uniformly from the top to the bottom of the pipe when the jackets are removed.

CURING

Upon removal of the pipe from the machine, they must be protected from evaporation until the concrete has properly hardened. This may be accomplished either by steam curing or by natural curing in which the pipe are sprinkled with water during the hardening period.

Briefly described, steam curing consists in storing the pipe in a room into which an atmosphere of water vapor is introduced and leaving the pipe there for a period of 18 hrs., when they are removed to the yard. Unless automatic sprinkling devices are used in the natural curing process and great care is taken in every detail of it, steam curing is to be preferred in every respect as insuring uniformity. Inasmuch as the curing process is fully as important as the use of the proper amount of good cement, good aggregate and proper consistency, it may readily be understood that if the pipe are allowed to harden for 12 hrs. before being put under sprinklers, they may be ruined. The fact that curing simply prevents the evaporation of water contained in the concrete must be emphasized. Although the pipe may be kept thoroughly wet, they can be expected to absorb no water during this process. The steam curing process gives the added advantage of accelerating the hardening of the pipe to such an extent that pipe steam-cured for 18 hrs. are as strong as if cured naturally at temperatures up to about 70° at the end of 10 das. Absolute uniformity is assured in steam curing where the pipe are run into a closed chamber and the steam is turned on a few hours after the pipe are made. In any event the pipe have no opportunity to lose water by evaporation caused by drafts and contact of warm, dry air with the pipe walls.

In the steam curing process, two points must be observed, as they have sometimes caused improper curing. The steam chamber must be so tight as to prevent circulation of air and the consequent existence of a warm atmosphere not thoroughly saturated with water vapor which results in evaporation of water from the pipe walls. Steam should not be allowed to enter the curing chamber under pressure in such a manner as to strike the green pipe. The effect of this is to heat the pipe quickly and cause the evaporation of water from the interior of the pipe wall and the destruction of the pipe.

Whether the pipe are made by the poured process or are tamped into the molds and the forms removed as

soon as the pipe are taken from the pipe machine, the concrete must be protected from evaporation until the hardening process is well advanced. The fact that a cursory inspection of the pipe does not show whether or not they are properly cured, leads to a neglect of this feature more than any other. The result is that when pipe are placed in the ground and subjected to the action of the liquid which they are to carry, and to ground water they are readily softened and destroyed.

The manufacturer should institute a system of testing his pipe and particularly at the outset tests are of the greatest importance in order that he may not be deceived as to the quality of the pipe which he is making. The writer recognizes three valuable tests which may be made on concrete sewer pipe; absorption tests, crushing tests and internal hydrostatic pressure tests.

Absorption tests are of prime importance as they detect the quality of the concrete in the body of the pipe. The fact that they are not so generally required as the other tests is because they do not seem to reproduce field conditions. Absorption tests should be made by drying the pipe at a uniform temperature until it shows no further loss in weight, then immersing the pipe completely in water and allowing it to remain so for a period of 48 hrs., when it should be removed from the water, wiped dry of surface water and weighed again. The gain in weight in lbs. divided by the dry weight of the pipe multiplied by 100 is the percentage of absorption.

Absorption tests were made by the California Glazed Cement Pipe Co., on 10 samples of pipe ranging in size from 6" to 14". These pipe were submerged in water for from 6 das. to 10 das.; the average absorption on the 10 samples was 1.87% by weight, the absorption varying from 1.19% to 2.49% on different samples.

A 11-in. concrete sewer pipe made of a mixture of 1 part cement and 2 parts sand in which 10.25% by weight of water to total dry materials was used to produce the consistency desired, showed a loss in weight of 1.68% by weight after curing 30 das. The remaining 8.5% of water was used in the hardening of the concrete and remained in the concrete when the pipe was thoroughly dry at ordinary temperature. The pipe was immersed in water for 10 das. and showed an absorption of 1.7%

These pipe were dried at atmospheric temperature before being subjected to the absorption tests.

The average of six absorption tests on broken pipe from the same company thoroughly dried and submerged for 10 days showed an absorption of 3.25%. The average of 13 absorption tests on whole pipe showed an absorption of 3.4%. These pipe were made of a mixture of 1 part cement to 3 parts aggregate.

Crushing tests give indications not only of the strength of the pipe but also of the strength of the aggregates used and the perfection of each step in the manufacture. Suitable machines are on the market which may be installed in a pipe factory to enable the manufacturer to test his product from time to time and check up the uniformity of the pipe. Standard specifications for strength under definite methods of testing for crushing strength are not available at this time. However, the manufacturer can check up the uniformity of his product without the use of standard specifications. The writer knows of no easier and more valuable tests than crushing tests to be applied in the factory. One test requires about 10 min. time. Comparison between concrete pipe and pipe of accepted quality may readily be made in any city. The manufacturer should not be content with inferior strength in concrete pipe as compared with the best vitrified clay pipe.

Hydrostatic tests are required in the specifications of some cities. The ends of the pipe are closed by means of bulk-heads and gaskets and the pipe are subjected to an internal water pressure. Specifications call for such requirements as the following: That the pipe shall be subjected to an internal pressure of 15 lbs. per sq. in. without showing seepage on the outer surface for a period of 5 min. and that the pipe shall withstand a pressure of 40 lbs. per sq. in. without fracture.

Manufacturers generally welcome the insertion of test requirements in city specifications, so long as all pipe which are eligible under the specifications are required to meet the same test.

In the foregoing paper the writer has attempted to make clear some of the most important steps in the manufacture of concrete sewer pipe. First, the selection of proper materials; second, the use of concrete of proper consistency; third, proper curing. Good concrete pipe are as strong when tested wet as when tested dry and are not subject to deterioration from sewage or from ground water.

¹From Specifications for the Construction of Sanitary Sewers in the City of San Diego

Information and Consultation: The How-to-Do-It Department

This magazine is for service. Let it serve you, and you help it to serve. You want special information. Ask us. We know the men who know.

Contraction Joints in Sidewalks

DISCUSSED BY R. D. GOODRICH¹ AND C. R. EGE²

"Why is it necessary to cut a sidewalk into slabs every 5' or 6'? What is the relation between the width of the sidewalk and the spacing of the contraction joint? Would it not do just as well to place a contraction joint every 20'? Should not sidewalk practice parallel the best method of handling the same problem in concrete road work?"

BY MR. GOODRICH

The question of contraction and expansion joints in a concrete sidewalk is one which can be properly answered only after a thorough consideration of the local conditions. The writer has seen concrete sidewalks in eastern cities which were buckled up so as to raise the adjacent blocks 3" or 4" at a joint. In this city it was necessary to put in expansion joints every 25' or 30'. These joints were made by setting a 1½-in. board between the blocks and removing this board after the blocks had set so as to leave an open joint. Some of these open joints have been nearly closed after a year's time. This may have been due to the use of cement which was improperly cured before its use, but it may also have been due to the construction of the sidewalk in hot weather, followed by a season of continuous wet weather, when the walk would become thoroughly saturated and expand to a considerable extent.

On the other hand, it has been found that under other conditions concrete will contract and that if contraction joints are not supplied,

cracks will appear about every 40' or 50'. On the face of it, it would therefore seem that contraction joints placed at intervals of every 20' or 40' might be sufficient.

We think, however, that there are other considerations which are of equal importance. Where trees are planted near the sidewalk it is found impossible to prevent their roots from extending under the sidewalk and their growth often causes a block to be raised out of alignment and grade. This is especially true where rapid growth trees like cotton-wood and box elders are used for shade. In such conditions we have found that if sidewalks are properly constructed with contraction joints the full depth of the walk, blocks may be raised by the roots of trees without cracking or injuring the walk. They can then be raised still further and the objectionable roots removed and the blocks re-laid to grade. We have known this to be done two or three times with the same block and it therefore appears to us that this is sufficient reason for continuing the practice of cutting sidewalks into blocks 5' or 6' in length.

BY MR. EGE

My experience with concrete sidewalks indicates that unless there is more or less settlement to be provided for, it is unnecessary to cut a sidewalk into comparatively short slabs. One point is certain, it will not prevent contraction cracks, unless the sidewalk slab is placed upon a smooth sub-grade or one which will permit the slab to contract or expand with the changes of temperature. When the slab is fast to the sub-

grade, the purpose of the contraction joint is defeated. The same observation applies to my experience in concrete pavements. When there is a probable settlement over a newly placed fill or bad ground, then the closely spaced joints will obviate a great many unsightly cracks in the slab, due to uneven settlement.

There are a number of customs in connection with sidewalk work which have become more or less "time-honored institutions," and I think that the practice of cutting the slab into sections 5' or 6' long is one of these traditions which might be done away with, except under certain conditions.

Cinder Concrete for Wall Construction

DISCUSSED BY EDWARD D. BOYER¹

"Are cinders and old No. 9 fence wire good material for a long wall 4" thick and 6' to 7' high? I am planning to trowel the surface with white cement and sand after the removal of the forms. Pilasters will be used 10' or 11' o. c. Is it possible to mold a coping in place by using plaster of paris molds?"

BY MR. BOYER

Cinders as an aggregate in concrete work should be used with discretion. Cinder concrete is not strong and where strength is required should never be used. It as a rule should never be used in reinforced work which comes in contact with water, as it is more or less porous and hence does not protect the reinforcement from corrosion. Due to the fact that it is possible to procure cinders so cheaply, the pilasters and wall might be built of

¹City Engr., Cheyenne, Wyo.

²Princ. Asst. Engr., Olympia, Wn.

¹Cement expert, Atlas Portland Cement Co., N. Y. C.

cinder concrete, reinforcing it as specified, if the surface were stuccoed thoroughly to keep out the penetration of the rain. The wall, however, would not be so strong as one built with stone or gravel as the aggregate.

As to the possibly of molding copings in place using plaster of Paris molds, we should consider it advisable to mold the coping and decorative shapes for the pilasters separately and place them on the cast pilasters.

properly reinforced, upon it. So much for the floor.

We note that there are a number of columns located in the cellar. The accompanying sketch shows the method that may be employed in making the waterproofing continuous over and around the columns. It will be necessary, of course, to make the waterproof concrete continuous with the floor slab and the masonry covering for columns may be either of brick or concrete. In either event we suggest that the floor coating be "coved" over the angle, with a fillet where the floor and column covering rested in connection with the making meet, in a way similar to that suggested in connection with making the floor coating and the wall coating continuous.

CLEANSE THOROUGHLY

The interior surface of foundation walls must be thoroughly cleaned of all foreign or latent matter in order to provide for a perfect bond between the waterproofed cement mortar that will necessarily have to be applied, and the walls. This may be done by thoroughly scouring the wall surfaces with a 10% solution of muriatic acid, after which all traces of this acid must be removed. The joints in the stone masonry must be raked out to a depth of 1", to provide for a key. Before applying the plaster coat of waterproofing cement mortar the wall surface must be carefully grouted, grout to be made of waterproofed cement and water, and mixed in a consistency similar to that of calceimine. The grout is to be applied with a brush and followed by a scratch coat of waterproof cement mortar, the scratch coat to have a minimum thickness of $\frac{3}{8}$ ". After this first coat has been applied and has set up sufficiently to scratch, it must be thoroughly scratched or rouged. Before thoroughly dried out and while strong enough to permit the application of second or finish coat, the second or finish coat is to be applied. Both coats are to be well troweled. Bring plaster coat to a point about 10" or 12" from top of proposed new floor level.

After walls have been completed place floor slab and bring finish top coat across and over angle where floor and walls meet by making a cove joint, and make continuous with plaster coating on walls.

This method has been followed for a long time around about N. Y. C. and from our experience we believe it to be an effective method of overcoming the infiltration of water either through the masonry or through

Waterproofing Cellar Walls and Floor

DISCUSSED BY FRANK J. PHELAN¹

"My cellar is subject to incursion of water during the spring months and I desire to waterproof it. The walls are of native lime rock set in lime mortar and are about 20" thick. There is no floor to speak of. I want the waterproofing to extend up about 4' 4" from the floor, that is, to the bottom of the windows as they are at present. The floor will of course be of waterproofed concrete. How shall I treat the walls? How shall I have the foundation under the columns made so as to get a perfect bond between them and the cement of the cellar floor? The head of water would rarely be over 1' but might be 4'. Would I need to have any expansion joints in a job of this kind?"

By MR. PHELAN

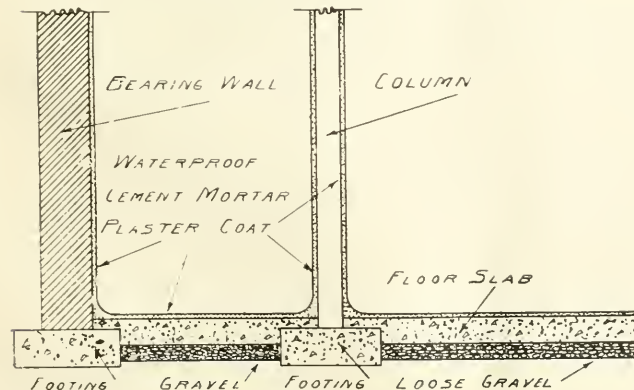
To overcome the condition outlined above is comparatively easy if logical methods are applied and if the work is performed by mechanics competent to handle work of this character.

We note that the maximum head of water equals 4' or more. This

in turn indicates, according to the accompanying table, a lifting pressure per sq. ft. of 250 lbs. It is necessary to provide against the lifting pressure due to this hydrostatic head by installing a floor slab either sufficiently strong or sufficiently heavy to offset maximum possible pressure.

If it is desired to install this work at a time when the water is present it will be necessary to dig a sump either inside or outside of the building, and so construct the sump that the bottom will be sufficiently deep to drain all of the water, thus providing against the possibility of the water coming in contact with the concrete used in the new floor slab. We would further suggest that the cellar bottom be excavated to a depth that would permit placing stone or gravel to provide drainage to the sump. Over this broken stone or gravel, place some building paper for the purpose of preventing the liquid cement mortar from coming in contact with the stone or gravel, and thus defeating the drainage scheme. After the drainage has been properly provided for, place the concrete slab, in the necessary thickness or

¹Sec., Integral Waterproofing Co., N. Y. C.



SKETCH SHOWING METHODS OF WATERPROOFING A CELLAR

the floors or substructures of buildings.

TABLE OF WATER PRESSURES

Hydrostatic Head Feet	Lifting Pressure per sq. ft. on Wall		Av. Pressure per sq. ft. on Wall	
	Pressure per sq. in., lbs.	(under floors) lbs.	Surface affected, lbs.	ft. on Wall
0.5	0.1	31.2	15.6	
1.0	0.13	62.5	31.2	
2.0	0.46	125.0	62.5	
3.0	1.30	187.5	93.7	
4.0	1.73	250.0	125.0	
5.0	2.17	312.5	156.2	
6.0	2.60	375.0	187.5	
8.0	3.47	500.0	250.0	
10.0	4.34	625.0	312.5	
12.0	5.21	750.0	375.0	
15.0	6.51	937.5	468.7	
20.0	8.68	1,250.0	625.0	
25.0	10.85	1,562.5	781.2	
30.0	13.02	1,875.0	937.5	
40.0	17.36	2,500.0	1,250.0	
60.0	26.04	3,750.0	1,875.0	
80.0	34.72	5,000.0	2,500.0	
100.0	43.40	6,250.0	3,125.0	

A Quick-Setting Cement

DISCUSSED BY SPENCER B. NEWBERRY,¹ C. W. BOYNTON² AND F. J. BEAL³

"If we were to need quick-setting Portland cement in car-load lots, could the cement manufacturer ship us cement, leaving out the gypsum used to control the set? Would this quick-setting cement develop concrete of the standard of standard Portland cement if the concrete was mixed and placed within five min. and left undisturbed to cure?"

BY MR. NEWBERRY

It is impossible, so far as I know, to make Portland cement which will at the same time be quick-setting and will show good tensile strength. Most people who ask for quick-setting cement really want quick-hardening cement, and it is well known that cement which is slowest in setting is generally quickest in hardening; that is, cement which does not show final set in less than eight hrs., for example, will show better strength at one day than that which sets in one-half hr. or one hr.

Omitting the gypsum would hasten the setting, but not the hardening and would diminish the strength at one day. The best way to secure quick hardening of concrete block or brick is to make the mixture with hot water, and to provide means for keeping the block or brick warm during the setting.

If especially rapid hardening is desired, as in case of casts, a 10% solution of calcium chloride may be used instead of plain water. Calcium chloride may be obtained at small cost from wholesale dealers in chemicals.⁴ This addition has no bad effect, causes very liquid mixtures to harden sufficiently to remove from molds within 24 hrs. and prevents formation of shrinkage cracks.

BY MR. BOYNTON

While some plants might be willing to ship quick-setting cement most cement manufacturers would not care to do so, because of the necessity for changing equipment and storage space to make this possible. The government once specified a quick-setting cement on some of its work, but discontinued this practice some time ago when the concrete obtained did not develop the strength of that mixed with standard Portland cement.

BY MR. BEAL

Cement without gypsum could be made and shipped but would of ne-

cessity require more work in the making, such as cleaning out all the bins and grinding machinery both before and after the grinding. This would put an extra cost on the cement. The quick-setting cement would set in less than five min. and would not develop concrete of the standard of standard Portland cement. I do not think, in consideration of the results, that a cement company would ship out a cement of this kind.

EDITORIAL DISCUSSION

The chances are that cement if shipped without the gypsum would have a flash set, and if so, it could not be placed satisfactorily even if it were to be used in 5 min. The set would probably be broken in placing the concrete and it would then harden so very slowly that the chances are it would not be satisfactory. We think that if early strength is desired, it would be better to use a cement of normal set, but one which would develop a high 24-hr. strength.

The Best Way to Handle Top Finish

DISCUSSED BY A. E. LINDA¹; JOHN T. SIMPSON²; LEONARD C. WASON³; JAMES BENTLEY⁴ AND C. W. BOYNTON⁵

"In pouring reinforced concrete floors is it customary to complete the different floors 'in the rough' and put on the top finish later? In designing a reinforced concrete floor, under what conditions of construction can the 3/4-in. or 1-in. cement mortar top finish be figured as an integral part of the slab and used in compression?"

"We were of the belief that it was best to put on the finish at the same time the base was poured, but have observed that on some of our large work western contractors are putting on the finish coat several weeks later. What is the best practice here?"

BY MR. LINDA

Relative to a discussion of the practice of including the cement finish in the floor slab, so as to form an integral part of the slab, my

observation has led me to conclude that, generally speaking, this practice has not been found entirely successful. There are a number of practical difficulties in the execution of such a method of construction.

It has been found that in putting on the cement finish before the concrete in the floor construction has set, the workmen frequently fail to cover the day's work before leaving in the evening; also, that at any time the concrete may set before they find time to put on the finish. Consequently the finish fails to adhere firmly to the concrete, and separates from it—in some cases, a long time after the building has been in service.

It is also found that rain interferes with surfacing the concrete, and that workmen drop building materials and walk over the floors, making them unsightly, and requiring further work and finishing before they can be put in use.

It is unquestionably desirable, if a cement finish is to be used, to have it a part of the slab. It gives strength to the slab at the particular place where it is needed; and, if it can be made a part of the concrete, prevents

¹Pres. and Gen. Mgr., Sandusky Portland Cement Co., Sandusky, O.

²Engr. in Charge, Information Bur., Univ. Portland Cement Co., Chicago

³Kirkville, Mo.

⁴Western mgr., Corrugated Bar Co., Chicago

⁵Arch. and engr., Newark, N. J.

⁶Pres., Aberthaw Constr. Co., Boston

⁷Sold by the Carbondale Chemical Co., Carbondale, Pa.

⁸Vice-pres., A. Bentley & Sons Co., Toledo, Ohio

⁹Engr. in Charge, Information Bur., Universal Portland Cement Co., Chicago

flaking and cracking off later; but, as already noted, the practical difficulties in handling this method more than offset the advantages as a general proposition.

I have known of the case of a building in which this method of putting in cement finish was used above the surface, separating from the slab a year or two after the building was first put in use, showing that, at best, it is an uncertain proposition.

It may be that experience will overcome these difficulties; if it does, most of these objections will of course be eliminated.

I may add, moreover, that I have recently had some confirmation of my view on this subject in that one of the most responsible contractors in the country practically refused to make a cement finished floor and preferred to put in a cinder concrete on top of the concrete floor so that the finish could be put on after the other work was out of the way and leave the floor in satisfactory and workmanlike shape. This change made a considerable increase in the cost of construction, which cost was probably borne partly by the owner and partly by the contractors, but the contractor insisted that he would rather stand all of the extra cost than to have his reputation suffer by having unsightly floors throughout the building.

By MR. SIMPSON

I have found that cement mortar finish placed later than 24 hrs. after the placing of the main concrete construction proves unsatisfactory from the fact that it in many cases becomes loose and in others the under concrete, being so thoroughly dried out, abstracts too much of the moisture from the top finish and causes the finish to dust up very materially.

I have had several occasions, however, to place cement mortar finish on top of concrete that had been installed for as long as 30 days, and in one case almost 60 days.

I followed a method of thoroughly sweeping all dust and loose particles from the top surface to be covered, then washed thoroughly with a hose, soaking it thoroughly. On top of this, I laid a thin grout, 1 part of cement and 1 part of sand, and with a heavy fibre broom scrubbed the thin grout over the entire surface. On top of this I placed 1 1/4" of rather dry and stiff cement finish composed of 1 part of cement and 2 parts of sand, and had this troweled down particularly hard. The result of this application, so far as I know, has been very satisfactory. One year after it had been put down it seemed to be in perfect condition.

I do not think, however, that the practice of putting the finish coat on later is a good one as in my judgment it would work out successfully in very few cases.

By MR. WASON

An important question which must be taken into consideration in designing a floor is whether a granolithic floor is put on as an integral part of the construction, or as a second operation, and if a second operation, what its thickness shall be. For economy's sake, both in materials and in labor, it is cheaper to put on the finish with the construction. Under these conditions, it is frequently impossible to keep off the floor long enough for it to harden sufficiently to prevent its being somewhat marred. If this is a serious objection, the finish must be put on as a second operation. As this does not bond sufficiently with the floor to be considered a unit, the construction should be thick enough to carry the load without any assistance from the finish.

If the finish be 1" thick it is almost safe for the contractor to guarantee that it will be loose in spots, whereas if 2" thick it is pretty safe to guarantee it as solid and satisfactory. This adds to the dead weight and the expense. It is necessary to settle these points before construction begins in order to get the minimum of cost and the maximum of efficiency, as the amount of forms bought and the conduct of work are influenced by it.

As to using the cement finish in compression, I should say that it would be safe to consider the cement finish an integral part of the slab and to count upon it in compression only when it is cast as a unit with the construction and is placed before the concrete of the floor has had time to dry or set.

Under very favorable conditions and with considerable labor, a second coat can be made to bond sufficiently well so as not to give trouble from the use of the floor on account of the wearing surface separating and becoming loose, but I do not think that even then it is proper to figure on it as adding anything to the strength of a floor.

The compression of the top surface can be compared with the compression on the edge of a number of sheets of paper. Such pressure would cause them to buckle and separate from one another, and so even if a second coat were thoroughly bonded the tendency would be to break the bond apart by direct tension between it and the lower layer due to this buckling action. It would

be very safe to say that although some parts of the floor might bond with sufficient strength there would be enough which did not to produce discredit and doubt as to the strength of the combination on the whole floor. Therefore, we reach the conclusion that we can only figure on the finish as helping the compression when it is cast as a monolith and never when cast in a separate operation.

By MR. BENTLEY

In regard to methods of finishing large areas of concrete floors, it may be stated that both methods referred to above are in use here. Wherever the weather conditions will permit it is always best to put on the top coat while the slab is green. When this is done it is well to clean off the surface of the partially set slab as much as possible and get off all the matter which has floated to the top in placing the concrete. This makes a much the better job if it can be carried out without damaging the surface of the finish.

Where the weather conditions will not permit this to be done, it is frequently necessary to put on the top coat afterwards. Where this is done it is absolutely necessary that all dirt and scale be cleaned off the slab before any finish is put on. This can be done only by going over the entire surface with heavy pointed bars and wire brooms, and then washing the whole surface clean with muriatic acid, being careful to wash the surface again with clean water before placing the top coat. The surface should then be thoroughly grouted with a neat cement grout and the top finish put down as dry as possible.

This will not make so good a job as if it were put down when the slab was green, and costs considerably more, but frequently, owing to adverse conditions, it has to be done.

By MR. BOXTON

While it is customary for many contractors in this locality to complete the various floors in a reinforced concrete building "in the rough," and apply the top finish later, still there is now a decided tendency toward the other method, that is, putting on the finish at the same time as the base is poured.

Although the latter practice requires that the floor be covered with sawdust, and possibly with boards, in order to protect it from injury when working on the floor above, we believe that it is the best practice since it eliminates the possibility of subsequent trouble arising through

failure to secure a proper bond between the fresh wearing surface and the already hardened concrete base. The use of the sawdust covering has a decided advantage that more than offsets the extra time and work it involves, since by its aid the wearing

surface may be protected from rapid drying and if the covering be kept wet during the first few days after the floor is laid a tougher, stronger and altogether more satisfactory surface is secured than is possible with the other method.

Expansion Joints in Reinforced Concrete Buildings

DISCUSSED BY G. C. STONE¹

"What satisfactory details have been worked out for expansion and contraction joints in long reinforced concrete buildings?"

BY MR. STONE

It has been my experience that each case needs to be considered on its individual requirements. It is rather difficult to lay down any general rules on the subject, other than that buildings under 450' in length seldom need to be provided with joints, and that a distinction must be made between *expansion joints*, and *contraction joints*.

The accompanying sketches illustrate a few typical methods of making the joints in a structure. Sketches *A*, *B* and *C* show types of joint construction for floors where double beams are framed into double columns. These figures are self-explanatory. Of the three, the type shown by Sketch *A* is preferable, because it

does not catch and retain dust in the joint.

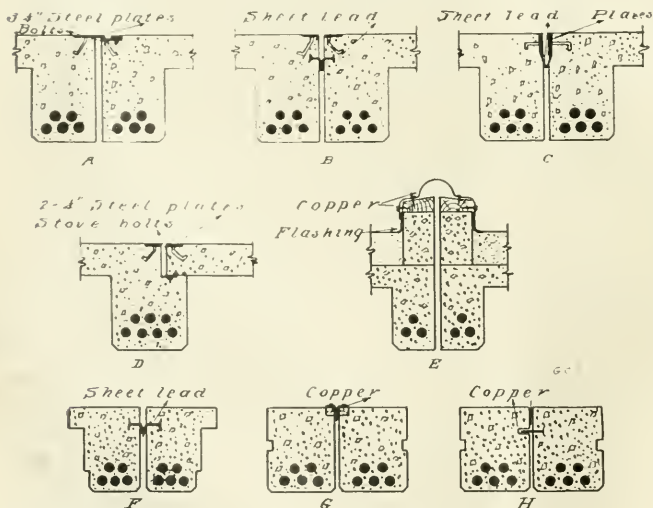
Sketch *D* shows a joint in which the double column has been eliminated by the use of a single beam, monolithic, with slab on one side only. The use of a single column, of course, simplifies the foundations.

Sketch *E* shows a simple form of joint for the roof where double beams and cinder fill are used. A similar construction would be applicable to a pitched slab roof, or to the single beam type of Sketch *D*.

Sketches *F*, *G* and *H* show three methods of providing a weather stop on exterior columns. Double exterior columns are preferable, because they insure a solid setting for the sash, and prevent the opening up of joints in the spandrel.

Acquire the safety habit. It is a habit that will never injure you.

¹Dorchester, Mass.



TYPICAL DETAILS FOR EXPANSION JOINTS IN REINFORCED CONCRETE

Is Cement a Reversible Colloid?

DISCUSSED BY ALFRED H. WHITE¹

"Somebody made a statement recently that cement was not a reversible colloid. What does he mean by this?"

BY PROF. WHITE

So far as I can see, there are only two possible ways of explaining the contraction and expansion of Portland cement. One explanation is that Portland cement is really a reversible colloid, and I think this is the more probable one. The other explanation is that a fresh portion of cement hydrates each time the cement becomes wet. Of course, we know that under ordinary circumstances only a small amount of cement actually put into concrete hydrates. If this latter explanation is correct there should be a limit ultimately in the number of alterations which are possible. So far I have not found any cement which fails to show the normal expansion and contraction on wetting and drying. It may be that I have not gone far enough with my experiments to have reached the limit.

Heat Generated by Setting Concrete

DISCUSSED BY WARREN A. HOYT²

"How much heat does concrete generate as it sets? Can this be counted on to resist freezing?"

BY MR. HOYT

The amount of heat generated depends upon the size or mass, the kind of cement used, the consistency of the mixture, also the richness of the concrete. For a 1:2:4 mixture, in mass 12" thick or more and medium consistency, placed at 70° F. would develop in 24 hrs. to 36 hrs. time a temperature of perhaps 120° F. to 150° F. I consider it not safe to count on this temperature to resist freezing. It is certainly not safe to consider this internal heat in building construction.

The safety movement is putting the ax into accident.

¹Prof. of Chem. Engrg., Univ. of Mich., Ann Arbor, Mich.

²Chicago

Correspondence: A Department in Which the Reader Becomes the Writer

This is your department. It is informal. Use it. This is the place for letters which have either inspiration or information for the "other fellow." It is well to remember that you are usually in his position. If you are to get the good out of these columns, why not help to make them good? Write about your work. Help the Other "other fellow."

Field Difficulties in Applying Stucco Coatings

A LETTER FROM E. W. LUTES¹

In a general way we quite agree with Messrs. Ware and Schott² as regards their conclusions. There is one point in connection with this matter which I feel is well worthy of serious consideration. The series of tests referred to in the article was made on slabs of cement stucco which were apparently pretty well dried at the time the coatings were applied under cover in a comparatively warm place, thus permitting the coatings to dry normally and most likely very much more quickly and harder than would occur if the coatings were applied under conditions which prevail in actual practice.

The conditions which we frequently meet in painting concrete and cement surfaces which have not properly dried in the first place and have not stood exposed to the weather sufficiently long to allow the active elements, such as alkali and other soluble elements to be neutralized or reduced to their lowest terms are somewhat different. Furthermore, coatings are frequently applied under atmospheric conditions which are not favorable and it seems to us that these things may necessitate a little different consideration of the whole subject and possibly, as a result, the final conclusions as to what represents the best and most satisfactory painting material might differ somewhat.

We feel, while the work which

Messrs. Ware and Schott have done is very commendable, that they have encountered the same difficulties which we ourselves do in making laboratory tests, that is, that it is most difficult to make these tests come reasonably near approximating conditions to be met in actual practice.

Standard Sized Catalogs and Pamphlets

A LETTER FROM ORIN C. STOUT³

No industry is more in need of standard sizes for catalogs and pamphlets than the concrete industry. The greater part of the catalogs and pamphlets in the interest of concrete contain valuable information for the engineers and executives and when these are placed in file become a desirable part of the engineer's reference library. However, it is very inconvenient to make quick reference to a library of catalogs and pamphlets with the multiplicity of different sizes. We have a few standard size index cards which everyone agrees are very convenient and great time savers. It is just as logical that we should have a few standard sizes for catalogues which would aid in the routine of filing, also making it easy of access for quick reference.

The writer selected a number of CONCRETE-CEMENT AGE at random

and noted a list of 41 trade publications and found that it contained 16 different sizes. The writer also investigated the catalogs of one firm that had 346 different sized catalogs. One company publishes nine different sized catalogs which required to be filed in nine different places, all of which could have been of one standard size. Extreme odd sizes of catalogs reach the library for filing and when there is no special place for these they are generally tossed around from place to place with papers of no value and at last reach the waste-paper basket.

A committee of the Technical Publicity Assn. has investigated the matter of standard sizes for catalogs for about 19 mos. and it has recommended 6" x 9" and 8½" x 11" for standards for all purposes. This committee also recommended 8" x 10½" for bulletins, as a large number of companies are now using letter heads of this size, thereby adding the convenience of filing the bulletins with the correspondence.

Committees appointed by the Am. Soc. of Mech. Engrs. and Am. Inst. of Architects recommend 8½" x 11" as standard size for both catalogs and bulletins.

The old prejudice, individuality and "human inertia" tend to retard a new movement of this kind. Of course, if individuality is desired by a company it should be displayed between the covers of a catalog, rather than to make it an odd size.

It is a duty which all manufacturers owe to their customers to adopt some standards, because the trouble entailed in the adoption of such standards is a small measure of the benefits that will be ultimately derived.

Don't "kid" about safety. You may be "the goat."

¹Dir. of Research, Sherwin-Williams Co., Cleveland

²"Paint Films as Protective Coatings for Concrete," by E. E. Ware and S. M. Schott, p. 117, Apr., 1914, issue

June, 1914

³Ellwood City, Pa.

Green Concrete in Place, Moved in Mass Without Apparent Damage

LETTERS FROM DANIEL B. LUTEN¹ AND W. S. GEARHART²

By MR. LUTEN

Referring to the article on bridge settlement on p. 83 of the Feb., 1914, issue, it is my opinion that the injuries were not sufficient to overcome the margin of safety in its design, and that the bridge stands today with a possible factor of safety of two, whereas it was doubtless originally designed with a factor of safety of four or five. It may be a question as to whether or not it is a safe structure under present conditions. Careful and continued observations may induce sufficient faith to permit it to stand.

In my own practice, we have of course had numerous instances of concrete in arches being injured by settlement of forms, but it has been our invariable practice to remove and replace the fractured portions. In the bridge referred to in this article, the cracks in the structure must result in greatly intensified compression at the points where maximum compression would occur. The structure may have been designed for 750 lbs. per sq. in., which in my opinion would be abundantly high, and yet it may at present be in such a condition that the maximum loading would cause compression of 1,500 lbs. per sq. in., and still not produce failure. But the bridge could hardly be called a safe structure.

There is one redeeming feature, and that is that a bridge in this condition will undoubtedly grow stronger with age as the concrete hardens. While this statement is not generally true of girder bridges, it does apply where there is an excess of steel. And if the bridge is properly designed there is of course an excess of steel in the structure over the concrete in its present condition. But this increase could never restore it to normal safety.

By MR. GEARHART

In regard to the letter by Charles H. Neal, published on p. 83 of the Feb., 1914, issue, describing how a concrete bridge girder under construction settled and was jacked back into place, Mr. Neal states that he started placing concrete in the forms early one morning and that about

2 p. m. a heavy rain fell which washed out nearly all of the supporting forms and caused the structure to sink 3 in. to 4 in. in the center. He also states that the structure was jacked up to place and the cracks grouted with cement mortar. He does not state, however, whether or not this work was done the same afternoon, but presumably it was. He gives the size and number of the reinforcing bars used, but does not state whether or not they were deformed.

A slow-setting cement was no doubt used and when the structure was jacked up it had probably not set very much and in a span of 20', the green concrete would not be distorted a great deal. However, after the cracks appeared it would seem that there was only one safe thing to do—take it out and replace it.

Evidently deformed reinforcing bars were used, for the bond certainly would have been broken on smooth bars. The use of slow-setting cement and deformed reinforced bars no doubt accounts for the apparent success of this structure after partial failure.

[*Editors' Note:* The above questions were referred to Mr. Neal, who states in reply that the work was jacked up and the cracks poured within 3 hrs. after the washout, and that mechanical bond bars were used.]

Flat Slab Work in 1900

A LETTER FROM WM. M. BAILEY¹

In regard to the early developments of flat slab construction, in 1900, while I was employed by the Eastern Expanded Metal Co., I designed and had built under my supervision a flat slab roof for a reservoir at the State Farm at Bridgewater, Mass.

This slab was reinforced in all directions with expanded metal, the metal being in the lower part of the slab, midway between columns, and raised over the columns near the top of the slab, as is the usual custom, to give negative tension strength at these supports.

The roof of the reservoir is still in good condition, and I think has been examined a number of times by different people interested in patents of flat slab construction.

The work was built by convict labor under the direct superintendence of Arthur Maynard, the superintendent of the construction.

You will see that this was constructed a number of years before any engineer even applied for a patent on this flat slab construction. I have always used the flat slab design since that time wherever I thought it was economy, and the best suited to the work.

Problems in the Use of Hydrated Lime

A LETTER FROM BENJAMIN A. HOWES¹

I hesitate to express myself on the subject of the use of hydrated lime in cement mortars, because my experience is too limited to warrant any general conclusion, and I have had no occasion which warranted a careful investigation of the matter. So I will simply relate some of my experiences that lead me to go slow.

First, when using hydrated lime in a 1:2:4 mixture for some floor slabs, to promote waterproofness, although more than the usual amount of mixing water was used, the concrete was found on removal of forms not to have flowed in around the reinforcement so well as when no hydrated lime was used. We discontinued the substitution of hydrated lime (for 12% of the cement by weight) and found a better distribution of concrete around the reinforcement, no further shrinkage cracks, and quite as watertight results. This was practical work in the field under my own observation but I cannot be sure that the hydrated lime was the only variable because from the nature of the work simultaneous check observations were not made.

Second, in an extended series of experiments and demonstrations for surface finishes, textures, and exposed aggregates, I used mixtures in which from 10% to 50% of the Portland cement was replaced by hydrated lime. The noticeable result was that the lime mixtures required a great deal more water for apparently equal plasticity (fluidity) than the concrete mixtures without lime and even so the lime mixtures did not flow into the plain box forms so freely, nor bind layer to layer so

¹Des. and cons. engr., Indianapolis, Ind.

²State engr., Manhattan, Kas.

³Published under same title as above

¹Designing and const. engr., Boston

¹Engr. and contr., N. Y. C.

completely as the concretes where no cement was replaced by hydrated lime.

Third, in experimenting with concrete mixtures for ornamental molded pieces such as capitals, brackets, urns and gargoyles we found that lime additions prevented the mixture from flowing into fillets, recesses, etc., and invariably produced serious shrinkage cracks which were avoided when no lime was added.

I judge from these and other experiences (the cements and limes used were standard brands) that for equal coating plasticity lime mixtures require a great deal of excess water

which on evaporation leaves in the mass either more porosity or greater shrinkage when finally set than when no lime is added.

In the case of mortar for plastering on lath, and brick laying, the porosity is generally not a serious fault and the shrinkage is prevented. The use of lime in the mixture is an advantage here, as it lubricates and produces a tenacity and plasticity (fat mortar as opposed to shortness of Portland cement mortar alone) which are most helpful in this work and quite different from the kind of plasticity or fluidity needed in casting.

The Use of Paint Films as Protective Coatings for Concrete

A LETTER FROM ALBERT B. PACINI¹

The report of investigations on paint films by E. E. Ware and S. M. Schott, published on p. 177 of the Apr., 1914, issue, is, in my opinion, an excellent piece of work in a field that needs much exploration.

This article suggests some speculations which I confess are purely theoretical, but which may prove interesting.

I believe that the life of a paint film applied to a cement surface depends chiefly upon the dampness of the surface at the moment of painting. Of two surfaces painted with the same medium, that one will offer greatest resistance to adhesion and greater evidence of paint disintegration which was most moist at the time the paint was applied. This is borne out by Table I, in which, comparing the action of dry and wet Portland cement on linseed oil, we note that although no appreciable difference is observable in the saponifying action of the two, the wet cement shows a marked increase in neutralization of the acidity. An ideal impermeable film of paint, applied to a perfectly dry cement surface, were there no circulation of water within the cement and of course no water reaching the cement through the paint, would last indefinitely.

The motion of water within a mass of cement is governed entirely by surface evaporation, after capillary equilibrium is established. If surface evaporation is checked by painting, no motion of the deeper contained water to the surface can take place. Of course this pre-supposes protecting every portion of the surface from

contact with the atmosphere, a condition never realized. Still, ordinary painting should check most of the motion towards the surface, and should tend to keep the surface in its original state of dryness or dampness. The paint-destroying water then, is that due to the original state of dampness of the surface at the time of painting? If this is high, enough dissolved alkali may attack the paint to destroy it; if low, the alkali reaching the paint film may not be sufficient to affect it. The quantity of this surface water of course depends upon the age and density of the surface, and is influenced by exposure to weather, richness of mix, amount of water used in mixing and amount of surface working.

It is evident, then, that misleading conclusions may be drawn from laboratory experiments, since a laboratory specimen may be made, allowed to dry and be painted, and at the conclusion of a test period of exposure to the atmosphere, the paint film may be found perfectly satisfactory. Care should be taken against arguing from these data that the paint used would give the same result when applied to a house wall. Seldom will a mass of concrete or mortar as found in construction work attain to the condition of dryness of a small specimen air-dried for a week in a laboratory. Seldom also will two laboratory specimens, even when made under exactly similar conditions, present the same state of surface hygroscopicity, and a quantitative expression of this condition would be desirable in a series of experiments made to test paint films.

An Amateur's Water Tower Makes Good

A LETTER FROM ARTEMAS WARD¹

I send you a photograph of a water tower, on arches, which gave me amusement one summer, at Shelter Island, and has proved a permanent blessing. It was erected without settled plan. I asked an engineer how much perpendicular and horizontal reinforcement it would need, and then, with the aid of one sensible Irishman—who had learned a little about concrete while working on my farm—and five or six cheerful Italian boys, it was erected.

Begin as a quadrilateral, on eight piers, it was changed by adding four more piers, making a square cross of the foundation, with the intention



AN INTERESTING WATER TOWER ON SHELTER ISLAND

of making a circular structure; then it was changed to an octagon by the carpenter's mistake in making the forms for the arches, and again changed to a circular shape above the floor which the arches supported. It was built of sand and gravel gathered on our own shore, and worked by day only, but kept damp over night with wet bags. We used two sets of forms, lifting one over the other as we went up. The tower stands 44' high, and 30' in diameter. I have used no waterproofing, but it has not leaked in two years' use, except for a slight dampness between the upper tank and the lower, which are separate.

All the water, some 60,000 gals.,

¹N. Y. C.

¹Chem., Bd. of Water Supply, N. Y. C.

passes to the upper tank, which supplies the house, and is always full. Its overflow fills the lower one, which supplies the gardens, their fountains and some farm buildings.

My walls begin at 12", and lessen to 8", and to 6" in the smaller tank.

All the plans, down—or up—to the castellated finish, were roughly drawn on scraps of paper, very generally on the train to the city. An iron staircase, which leads to the top, was put up crookedly by "competent mechanics," but, in common with most amateurs, I am contented with the work because I had a hand in it.

A Concrete Waste-Burner

A LETTER FROM E. B. SHIELDS¹

At our mill at Selleck, we have a concrete waste-burner which we think is one of the best refuse burners on the Pacific coast today.

This burner is 31' inside diameter, 83' high, complete, and 105' over all.



A CONCRETE WASTE-BURNER FOR SAW MILL AT SELLECK, W.N.

It is built with 10-in. concrete wall, with 4-in. dead air space, then an 18-in. wall of brick, one course being of common sand-brick, the other course, for 60', being lined with fire-brick. From the line of the fire-

brick to the top of this burner is a 12 in. wall.

Our mill cuts from 145,000 ft. to 170,000 ft. of lumber per day and at times 50% of our cut is hemlock. We have had to kindle a fire in this burner every morning since it has been in operation and we think it would take care of a mill cutting twice the amount of lumber that we are cutting. Such a burner can be built 25% cheaper than any steel-jacket or water-jacket burner.

Concrete Development in South Africa

A LETTER FROM GERALD CARSON¹

There are promising possibilities in the use of concrete materials and equipment in this part of the world. Rhodesia is beginning to realize, along with other things, that irrigation schemes—large and small—are an absolute necessity. This country is admirably suited for carrying out successfully any irrigation programs and within the next year I hope to see many useful and profitable works carried out.

In the southern colonies a good deal of reinforced concrete work has been done, but in Rhodesia and further north, except in a few buildings, engineers and contractors have not given very much consideration to the matter. I see the possibility and I want to take advantage of the opportunities offered.

Rhodesia at present is an expensive country and anyone who can bring along suggestions whereby the cost of construction work can be reduced will be heartily welcomed. Owing to the prohibitive cost of construction, agricultural and township work has been delayed. I want to be in touch with American manufacturers of concrete materials and equipment and receive the latest information on the various systems, the available data and formula, etc., with a special reference to irrigation work, bridges, roads, etc. I am especially interested, too, in fence posts. Can they be made at a reasonable figure?

Much can be done to increase a man's efficiency by strengthening the personal tie between the workman and the manager. If both remember that their attitudes to each other are practically those of buyer and seller, and demand the same tact and courtesy, many troubles would be avoided.

The Economy of Bulk Cement

A LETTER FROM GORDON WILSON¹

I was greatly interested in the letter from C. L. Brown, manager of the Northfield Iron Co., on the subject of measuring cement for small batch mixers, which appeared on p. 136 of the Mar., 1914, issue. Mr. Brown is absolutely right, and his impatience with the old timers who cling to the 14-bbl. sack as the only possible means of measuring cement is fully justified. No one has ever urged any objections to the wheelbarrow, to say nothing of more refined devices, as an accurate measure for bulk sand or bulk stone, in spite of the fact that there are from five to 10 chances of making concrete too rich, or too lean, by improper measurement of the aggregate, where there is one chance of error in the measurement of the cement.

The progressiveness of the American people is a tradition to which we all point with pride but which will never become a fact in the concrete industry until the American people have established the practice of buying cement packages only when those packages are absolutely essential to the handling of the material.

Paper bags cost the consumer of the cement 10 cts. per bbl., plus loss due to breakage. The average cost of cloth sacks is about 5 cts. per bbl., exclusive of interest on the investment in sacks. To these costs must be added the extra labor of handling, untying, and emptying the packages, an item of expense which may be conservatively placed at a minimum of 2 cts. per bbl. American cement users can measure cement accurately at a cost lower than 7 cts. or 12 cts. per bbl., so a great many of them are wasting money by not using their cement in bulk.

We should like to buy a few copies of *Cement Age* for August, 1911, and will advance the subscription period of any subscriber for three months in return for a good copy of the issue named. Please write before sending the magazine as we need only a limited number.—CONCRETE-CEMENT AGE, Detroit.

All appliances used in your work should be frequently and carefully inspected.

¹Vice-Pres. and Mgr., Pacific States Lumber Co., Tacoma, Wn.

¹Consult. engr., Bulawayo, Rhodesia, South Africa

¹Asst. secy., Universal Portland Cement Co., Chicago



FIG. 1—GENERAL VIEW OF THE PLANT OF THE REMINGTON ARMS-UNION METALLIC CARTRIDGE CO., WINDSOR, ONT.

This shows at the left the construction tower of the runway, crossing transversely the saw-tooth ridges

Field Notes on Saw-Tooth Concrete Roof Construction, Windsor, Ontario

An interesting example of light concrete roof construction has just been completed at the new building for the Remington Arms-Union Metallic Cartridge Co., Windsor, Ont., Canada. The general construction of the building is the saw-tooth type, the slope of the separate roofs being 30° . There are nine sections, six of which are about 150' long, and three 50' long. The skeleton work of the

by a smooth concrete slab about $1\frac{1}{2}$ " thick, in which was embedded a wire mesh² of mild steel, the mesh being fastened to the bottom of each corrugation of the sheets by special clips, thus insuring the position of the wire at the bottom of the slab and giving a roof of maximum strength.

²Page Woven Wire Fence Co., Adrian, Mich.

The steel sheets are of open-hearth steel covered on both sides with asphalt and white asbestos and present a very attractive appearance as an interior ceiling for the building. There was no necessity for plastering the under side. It is claimed that the asbestos covering and asphalt binder give a highly insulated roof. The corrugations of the sheets are about $3\frac{1}{4}$ " deep and about $23\frac{1}{8}$ " wide.³

The erection of the sheets was simple and required but two men to handle the material on the roof and a laborer on the ground who raised

³A detailed description of this material and some tests made with it will be found in the Jan., 1913, issue, p. 47

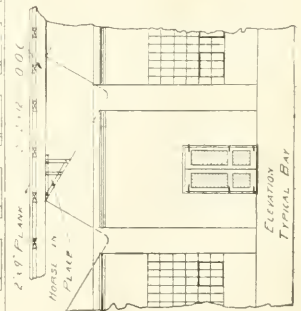
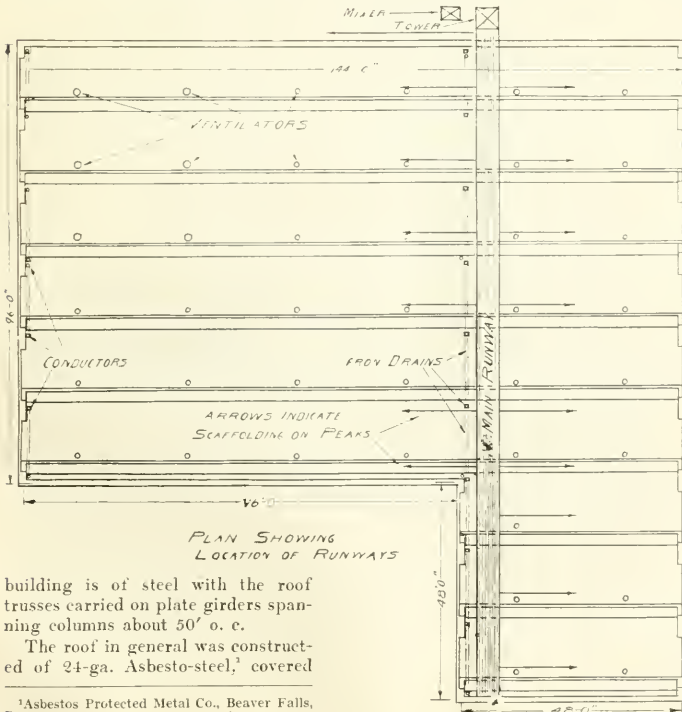


FIG. 2—GENERAL PLAN OF A MANUFACTURING PLANT AT WINDSOR, ONT.

This is a detailed elevation showing the layout of the saw-tooth roof, the position of the tower, the transverse runways and the lateral runways for each bay

building is of steel with the roof trusses carried on plate girders spanning columns about 50' o. c.

The roof in general was constructed of 24-ga. Asbesto-steel,³ covered

³Asbestos Protected Metal Co., Beaver Falls, Pa.



FIG. 3—A DETAILED VIEW SHOWING THE POSITION OF THE TOWER AND THE RUNWAY
At the right in the immediate foreground the asbestos steel sheathing has not been joined; at the left a ventilator obstructs the view of the tower



FIG. 4—STRUCTURAL DETAILS SHOWING THE ARRANGEMENT OF THE ASBESTOS STEEL, CONCRETE SLAB, STRUCTURAL STEEL PURLINS AND GUTTER DETAILS

the sheets to the men and who also placed the clips for attaching the reinforcing mesh on the sheets before they were raised. Special purlin clips were furnished for fastening the sheets to the roof purlins in such a manner that the fasteners were not visible from the under side. In the same manner the sidelaps of the sheets were fastened to form a continuous joint in the corrugations and did not destroy the uniform appearance of the under side of the roofing sheets.

The erection of the roofing sheets was completed just about the same time as the brick parapet walls were carried up to the roof line and the concrete work started immediately. A serious problem of preventing this very thin slab of concrete from freezing had to be taken care of at this time, as the temperature was very low.

EQUIPMENT AND PLANT ARRANGEMENT

A $1\frac{3}{4}$ -cu. yd. mixer⁴ connected to a steam engine with a 10-h. p. boiler,

cape. The steam pressure was kept up all night, a night watchman taking care of the fire, and the steam was allowed to escape into the sand pile all the time.

The mixer and the tower were located at about the center of the south wall. The tower was built of 2×4 's spiked together to form 1-in. x 1-in. corner posts and 1-in. boards for braces. This tower was about 40' high. The cage was made large enough to carry one wheelbarrow. A horse was used to raise the material. A counter-weight which was hung on the rope which passed over the sheaves on the top head frame and the bottom foot block assisted materially in decreasing the load the horse had to lift. A curious fact was that the horse had no difficulty in raising the load but seemed frightened when the cage was lowered, and the load of this cage pulled him back. A book made of $\frac{1}{4}$ -in. band iron hung from the head frame and was swung under the cage as it reached the top, thus taking the load away from the horse and insuring against danger while the full wheelbarrows were unloaded and the empty ones sent down.

A central runway about 5' wide was constructed, crossing at right angles the stretches of saw-tooth gables, and the concrete was delivered to each section of the roof from this runway. Small triangular horses (which are shown in the sketches) were made on the ground, and these were used to support the plank runways. They were easily put in position and were shifted from one section of the roof as it was concreted to the next one with very little labor and loss of time. In fact, the concreting proceeded continuously without any necessity for stopping to shift the scaffold. The horses were



FIG. 5—A DETAILED VIEW SHOWING TRIANGULAR HORSES FOR THE LATERAL RUNWAYS

This view shows in detail the ventilators and the mesh reinforcement used; the sheets nailed along the horses are the screeds, ready to be placed; a ventilator is shown at the left

⁴T. L. Smith Co., Milwaukee

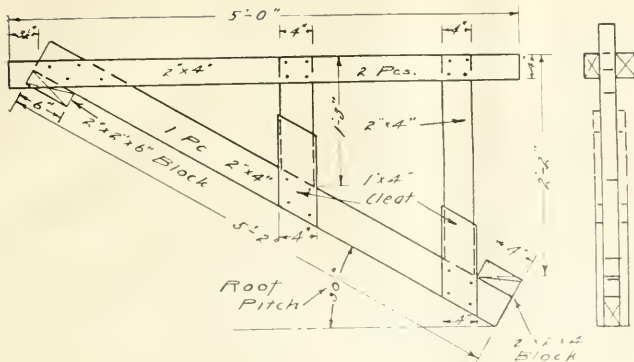


FIG. 6—DETAIL SHOWING THE CONSTRUCTION OF THE TRIANGULAR RUNWAY HORSES

made so that they hooked over the top purlin and the bottom end rested on the purlin below, thus taking all the load off the sheets and slab.

PLACING THE CONCRETE ROOF SLAB

In placing the concrete, screeds were nailed to the sheets about 8' o. c., and these screeds were left in the concrete slab to serve as nailing strips for the waterproofing. Dry concrete was first placed in the gutters the entire length of the section and then the slab was poured and the gutter finished at the same time. On account of the steep pitch the consistency of the concrete was very dry. The surface was floated to a smooth finish.

As an added precaution against freezing the concrete was also protected after it was poured. Large salamanders were placed in the room below and tarpaulins were hung from the roof trusses to confine the heat at the portion of the roof at which the concrete was being poured. The ends of the saw-tooth sections were boarded up and all over the roof 1-in. boards were placed, on top of which were laid bags filled with manure. In this way the roof was protected against cold from all possible directions. The handling of the manure in this way proved very expeditious and also eliminated dirt and loss of material which would have resulted if the manure had been placed loose on the roof.

The ventilators shown on the building were bolted to the sheets before the concrete was poured and the metal of the asbestos sheets cut out for the round openings at the same time the sheets were erected.

The work was interrupted several days on account of snow. However, by employing a large gang of laborers and cement finishers, the concrete was all poured within 8 das. after starting.

A standard built-up waterproofing was installed and the flashings at the parapet walls and at the ridges were the standard asbestos protected material used for flashing purposes.

All of the erection of sheets and placing of the concrete was per-



FIG. 7—A DETAILED VIEW SHOWING GUTTER CONSTRUCTION

In this view the man with a wheelbarrow has come out along the lateral runway and is shoveling a stiff mortar down the chute to the gutter. The man below is tamping and working this into place with a round-pointed shovel. It will be finished immediately by a finisher and covered with bags of manure

²By the Canadian plant of Bird and Son, Hamilton, Ont.

formed by the Asbestos Protected Metal Co., Beaver Falls, Pa., under the supervision of Meyer Davis, this firm's engineer representative.



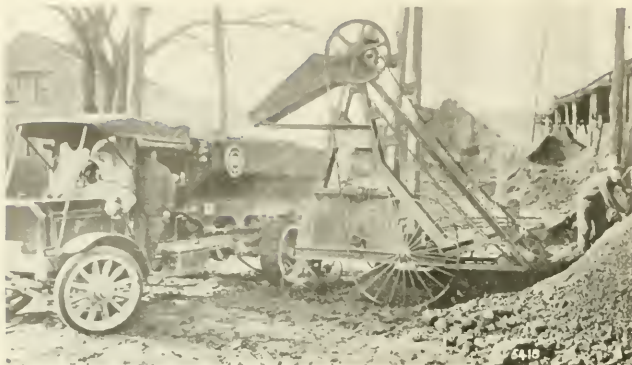
FIG. 8—OPERATING VIEWS IN SAW-TOOTH ROOF CONSTRUCTION

Above is shown a finisher floating the incline slab. In this view he is working to a screed, which has been placed at the end gable. He works from a board to which cleats have been nailed and which keeps him from sliding down the incline. Below a view shows the gunny sacks full of manure ready for placing in the gutter

A writer on principles of efficiency makes this statement: "We have interposed the device of wages between basic need and its satisfaction. Wages, therefore, acquire the importance of both, and wages are also the cushion between anarchy and civilization."

Tests have shown that chrome leather lacing is of considerably higher strength than ordinary rawhide or calf-skin lacing, and it seems apparent that it develops greater serviceable strength when used in splices.

Do not turn on any electricity, gas, steam or water, or set in motion any machinery, or throw down any material, without seeing that no one is in a position to be injured.



A MECHANICAL ELEVATOR AND LOADER MAKES MOTOR TRUCKS MORE EFFICIENT

Making the Motor Truck Pay in Contracting

By H. D. PRATT¹

The motor truck has come to stay. Its ability to carry bulk material long distances in quantities unheard of 10 yrs. ago., and at a high rate of speed, makes it possible to reduce materially the cost of transporting large quantities of stone, coal, sand, gravel, etc. The speed of travel is high as compared with the horse-drawn vehicle. The unloading is automatic, the body being dumped by the mere turn of a lever by the truck operator. In many cases the truck is loaded from an overhead chute, but more often the material to be moved lies on the ground in storage piles, not only in regular storage yards, but in streets, roads and wherever it is most convenient to store. The loading of this material from ground storage piles becomes a different matter. The high cost of loading auto trucks with material carried on ground storage is one of the factors which have retarded the sale of trucks for this work.

The truck which is so quick and convenient for handling several tons at a load must necessarily be high to hold the load. Shoveling by hand means that the truck spends probably more than half its time waiting at the storage pile to be loaded, and between trucks the shoveling gang is idle. A good average day's work for a shoveler is 20 tons of gravel, less of stone, and slightly more of sand. Not only is the truck standing idle while being loaded, but the loading by hand costs 8 cts. to 12 cts. a ton. Here is a bad leak in what should be an up to date and efficient job of handling.

Portable wagon and truck loaders,

now available, effectively stop this leak. The accompanying illustration shows a loader,² a bucket elevator which is mounted on large wheels, and, with power supplied by a motor or gasoline engine, will load sand, gravel or coal at the rate of a ton per min.

The truck driver trims the truck with a shovel, and one, two or three men, depending on the nature of the material to be handled, trim and feed to the loader. This combination will load the truck at a cost of $2\frac{1}{2}$ cts. to 5 cts. per ton, the higher cost being that of handling crushed stone, with coal at the low end, and sand and gravel following in order. The saving of about 6 cts. per ton thus effected is a large item in these days of close margins and competition and marks the loader as a useful and necessary adjunct of the motor truck.

²Made by the Link-Belt Co., Chicago



DETAIL OF RESIDENCE OF MASON MAURY, ARCHITECT, LOUISVILLE, KY.

There is also a growing demand for a further combination of truck and loader, namely, a truck with loader elevator mounted on the rear end of the body, arranged to lower into a storage pile when the truck is backed up to it, and also to raise clear of the ground when not in use. The elevator is supported independently of the dumping body, and is driven, through a clutch, by a connection to the truck transmission. This combination results in a truck which can be loaded by its driver with or without a helper in a few minutes, and does away entirely with the necessity for a loader-operator who is idle between trucks.

An Example of Rough Stucco Coat

The accompanying illustration gives a detail view of the home of Mason Maury, archt., Louisville, Ky. It is a story-and-a-half dwelling of the true bungalow type, built about three years ago, and is a striking piece of stucco work because of its unusual roughness. The last coat of stucco was applied with a whisk-broom and left as heavy and rough as possible. The stucco coats are $1\frac{1}{2}$ " thick, on metal lath. One of the advantages sought by Mr. Maury in the very rough finish, besides its attractive appearance, was that it would conceal such minute cracks as might develop, which, as Mr. Maury points out, frequently mar the appearance of a smooth or comparatively smooth stucco surface.

¹Engr., Link Belt Co., Philadelphia

Current Prices, Concrete Materials

Portland Cement—The cement market has advanced very little in the last month, except in certain localities, and the demand is light. Prices given are f. o. b. cars at points named, including cloth sacks, for which, in general, 40 cts. per bbl. (4 sacks) is refunded on return in good condition. Prices per bbl. (including 4 cloth sacks) are as follows: Boston, \$1.72; New York, \$1.58; Chicago, \$1.55; Peoria, \$1.59; Pittsburgh, \$1.50; New Orleans, \$1.65 on dock; Memphis, \$1.82; Cleveland, \$1.58; Detroit, \$1.59; Indianapolis, \$1.63; Columbus, \$1.67; Toledo, \$1.54; Ft. Wayne, \$1.54; St. Louis, \$1.55; Milwaukee, \$1.60; Minneapolis and St. Paul, \$1.70; Montreal, \$1.75 to \$1.80; Toronto, \$1.95; Winnipeg, \$2.40 to \$2.50; Kansas City, \$1.63; Davenport, \$1.60; Omaha, \$1.68; Portland, Ore., \$2.10; Spokane, \$2.20; Seattle, \$1.90; Tacoma, \$2.00; Duluth, \$1.78.

Crushed Stone—1½-in. stone, prices per cu. yd., f. o. b. cars in carload lots, unless otherwise specified. Boston, 90 cts. per ton at the quarry; New York, 90 cts. to \$1.00, in full cargo lots at the docks; Chicago, \$1.15; Toronto, 75 cts. per ton at quarries; Spokane, \$1.25; Seattle, \$1.25; Portland, Ore., \$1.10; Tacoma, \$1.25.

Gravel—Prices given are per cu. yd., f. o. b. cars in carload lots unless otherwise noted. Boston, 75 cts.; New York, 90 cts. to \$1.00, in full cargo lots at the docks; Chicago, \$1.15; Portland, Ore., \$1.10; Spokane, \$1.50; Seattle, 75 cts.; Winnipeg, \$1.85; Tacoma, 60 cts.

Sand—Prices are per cu. yd., f. o. b. cars in carload lots unless otherwise indicated. New York, 50 cts., full cargo lots at docks; Chicago, \$1.15; Toronto, \$1.15; Portland, Ore., \$1.10; Spokane, \$1.25; Seattle, 75 cts.; Winnipeg, \$1.75; Tacoma, 60 cts.

Reinforcing Bars—The demand is increasing but the prices in general are about the same as those given last month. Pittsburgh base quotations on mill shipments f. o. b. cars, are from \$1.15 per cwt., with the prevailing extras on bars under ¾" or base. The following are quotations on base bars per 100 lbs., for mill shipments from other points, f. o. b. cars: New York, \$1.31; Philadelphia, \$1.30; Chicago, \$1.33; Portland, Ore., \$1.25; Spokane, \$2.25; Seattle, \$2.25; Tacoma, \$1.90.

Shipments from stock are being made at the following prices per cwt. f. o. b. cars: Pittsburgh, \$1.65; New York, \$1.90; Cleveland, \$1.80; Cincinnati, \$1.80; Chicago, \$1.70; Montreal, \$2.15; Toronto, \$2.15; Winnipeg, \$2.50; Portland, Ore., \$2.10; Spokane, \$2.55; Tacoma, \$2.05; Seattle, \$2.75.

Metal Clips for Supporting Bars—\$7.25 to \$8.00 per 1,000, depending on size.

For the majority of the prices given we are indebted to the Universal Portland Cement Co., Sandusky Portland Cement Co., Concrete Steel Co., American Sand & Gravel Co., Chicago, and F. T. Crowe & Co., Seattle, Portland, Spokane and Tacoma.

Reinforcing bars for mill shipments are in general sold on a Pittsburgh basis; this is, at the Pittsburgh quotation plus the freight to the point in question, and with the following list of freight rates on finished material and the Pittsburgh quotation given, the price of bars at any of the points listed can be readily computed.

Organizations

American Cement Pipe Association, Secretary, E. S. Hanson, 538 S. Dearborn St., Chicago.

American Concrete Institute, Edward E. Krauss, Secretary, Harrison Building, Philadelphia, Pa.

American Highway Association, I. S. Pennybacker, Jr., Executive Secretary; Charles P. Light, Business Manager; Colorado Bldg., Washington, D. C. Fourth American Road Congress, Atlanta, Ga., Nov. 9-14.

American Road Builders' Association, Secretary, E. L. Powers, 150 Nassau St., N. Y. C. Convention, Chicago, December 14-17.

Association of American Portland Cement Manufacturers, Percy H. Wilson, Secretary, Land Title Building, Philadelphia, Pa.

Canadian Cement and Concrete Association, William Smith, Secretary, 57 East Adelaide St., Toronto, Ont.

Cement Products Exhibition Co., 208 S. LaSalle St., Chicago, Ill.; J. P. Beck, General Manager. Show, Chicago Coliseum, Feb. 10-17, 1915.

Iowa Association of Cement Users, Secretary, H. H. Dean, Glenwood, Ia.

National Conference on Concrete Road Building, J. B. Beck, Sec., 208 S. LaSalle St., Chicago.

Nebraska Cement Users' Association, Secy.-Treas., Frank Whipperman, Omaha, Neb.

Northwestern Cement Products Association, J. C. VanDoorn, Secretary, Security Bank Bldg., Minneapolis, Minn.

From Pittsburgh, carloads, per 100 lbs. to:

Albany	16	cts.
New York	16	"
Philadelphia	15	"
Baltimore	14½	"
Boston	15	"
Buffalo	11	"
Norfolk	20	"
Cleveland	10	"
Birmingham	45	"
Columbus	12	"
Cincinnati	15	"
Louisville	18	"
Chicago	18	"
Richmond	30	"
Denver	84½	"
St. Louis	22½	"
New Orleans	30	"

Another McCullough

An error in the further account of the proceedings of the National Conference on Concrete Road Building in the May, 1914, issue occurs on page 237. The part in the discussion of mixing and placing concrete credited to J. S. McCullough, Fond du Lac, Wis., should have been credited to Ernest McCullough, Chicago. We are sorry to have made the mistake.

We should like to obtain a copy of *Cement Age* for August, 1911, and a copy of *Concrete Engineering* for July, 1909. Anyone having a copy to spare in exchange for a 3 months' extension of his subscription please notify: CONCRETE-CEMENT AGE, Detroit, Mich.

Next Chicago Cement Show February 10-17, 1915

The next cement show of the Cement Products Exhibition Co. will be held in the Coliseum, Chicago, Feb. 10-17, 1915. The announcement comes from General Manager J. P. Beck that it has been decided that it will be more advantageous to exhibitors to have the show of somewhat shorter duration and give a longer time in which to place and arrange exhibits. Further details of the exhibition are promised for an early date.

From time to time CONCRETE-CEMENT AGE has commented upon the establishment of testing laboratories all over the country, and again it finds a source of gratification in the fact that Canada is considering the establishment of a national testing laboratory. The matter has been under consideration by a committee of the Canadian Soc. of Civ. Engrs., and while so far the government has not decided to establish a laboratory the Society has not abandoned its efforts toward that end, and the council is undertaking to use its efforts with the government to have at some future time, such a laboratory established for testing all materials of construction in the Dominion.

New Equipment, Methods and Materials : New Tools with Which the Industry Works

The progress of the Concrete Field is measured by the development of its tools. Manufacturers are constantly producing new and better methods, materials and machines. These are of real interest to those men who want to improve the quality of their work, decrease its cost, increase its quantity. Here are published descriptions of recent developments in the field.

A Small Revolving Sand Screen

The accompanying illustration shows a gravel screen to be operated with a very small amount of power. It can be turned readily by hand or attached to a mixer or other machinery with pulley and belt.

The machine is of metal construction, substantially built. The hopper and gravel chute are made of heavy galvanized iron, legs of angle iron; the smaller castings are of gray iron.

The cylinder is hung on a $\frac{3}{4}$ -in. turned steel shaft. The wheels in the cylinder are specially made with a view of allowing an easy passage for the coarse gravel.

The screen is of galvanized wire cloth, being clamped in place by two spring steel bands, which are easily removed in changing to screens of different mesh.

A patent cut-off in the bottom of hopper regulates the amount of sand to feed into the screen.

One of the features of this machine is a patented tapping device which can be regulated by the crank operator so that it will strike light or heavy blows, or it can be thrown out of gear altogether. The revolving

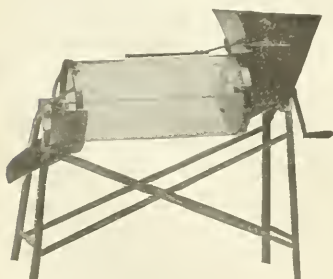
cylinder is about 13" in diameter and 30" long, and can, of course, be fitted with screens of various sizes. The top of the hopper is about 4' from the ground and the crank about 3'. The crank can, if required, be attached to the opposite end of the cylinder. The entire machine, set up for shipment, weighs about 125 lbs., and is now put on the market by the Hall-Holmes Mfg. Co., Jackson, Mich.

A Power Polishing Machine for Terrazzo Work

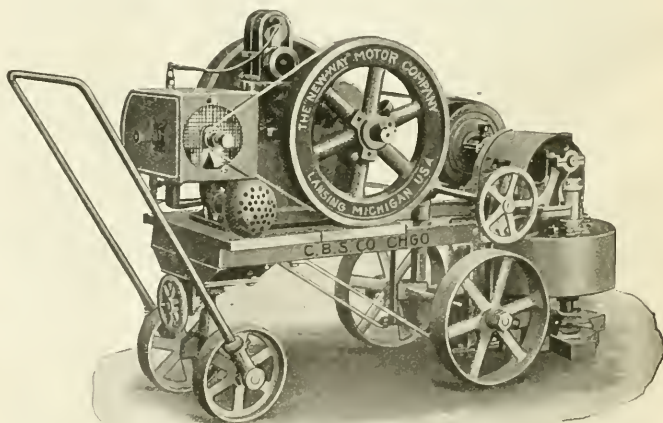
Producing terrazzo finishes on marble and concrete floors with power machines is becoming standard practice. The machine shown in the accompanying illustration, built by the Chicago Builders' Specialties

Co., Chicago, can be operated by either gasoline or electric motor. These machines are manufactured in two sizes, one, the largest, equipped with a $3\frac{1}{2}$ -h.p. gasoline engine and weighing, with the engine, 1,000 lbs. The smaller size machine, operated by $2\frac{1}{2}$ -h.p. engine, weighs about 425 lbs. The power from the engine is transmitted through beveled gears to the set of revolving carborundum blocks. Each shoe holds three blocks and there are four shoes, giving a rubbing surface of 12 carborundum blocks. The shoes rotate so that the motion of the machine is always toward the center. This throws the water under the blocks and keeps the work in good condition.

On ordinary terrazzo or mosaic floor a large machine produces about 750 sq. ft. for a day's work. The small machine will produce about 500 sq. ft. for a day's work.



SAND SCREEN



A POWER MACHINE FOR POLISHING TERRAZZO

Continuous Mixer Equipped For Auto Traction

A 1914 model of the "Coltrin" mixer, manufactured by the Knickerbocker Co., Jackson, Mich., is equipped with a traction drive in the following manner:

The countershaft which drives the drum is extended about 18" as at *A*. This shaft is fitted with a worm 5" in diameter and 8" long. The rotation of this worm is controlled by a jaw clutch. This worm *B* engages a gear *C*, which drives a cross-shaft *D*, which, in turn drives the two rear wheels through chain and cogs sprocket. The gear and worm are cut from high carbon steel, case-hardened, are enclosed in a dust-proof case and revolve in an oil bath. The drive sprockets are 61½" in diameter; the driven sprocket is 22" in diameter.

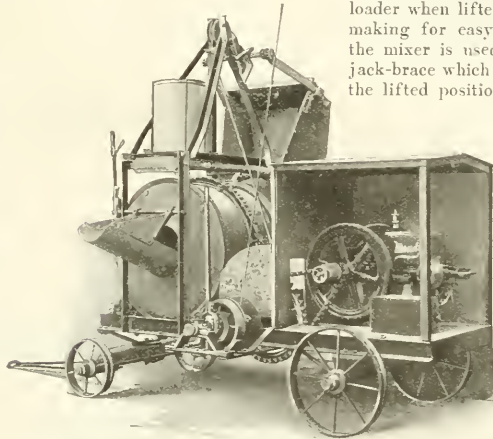
In turning corners, the unequal traction is provided for by means of spiral jaw clutches in the driving sprockets, which permit the sprocket on the outside to disengage itself automatically, thus eliminating the undue strain which would otherwise occur owing to difference in revolutions of the rear wheels.

The mixer, which otherwise is a standard Coltrin model, has a per hr. capacity of 12 cu. yds. of concrete with crushed stone, or 18 cu. yds. with bank-run gravel.

The mixer is equipped with a 4-h.p. gasoline engine and weighs, complete, about 3,000 lbs.

A Light Batch Mixer With Hoist Attachment

The small batch mixer is demonstrating every day its efficiency on construction work. Of especial interest in this development of small batch mixers is the way in which some of them are equipped with a hoist which will handle effectively and economically practically all the material the mixer can turn out. The American Cement Machine Co., Keokuk, Ia., now has on the market a low-priced batch mixer which is equipped in this way. The accompanying illustration shows the essential features of this mixer. The drum is of the standard type, chain driven. The gasoline engine with which the mixer is equipped has a surplus power.

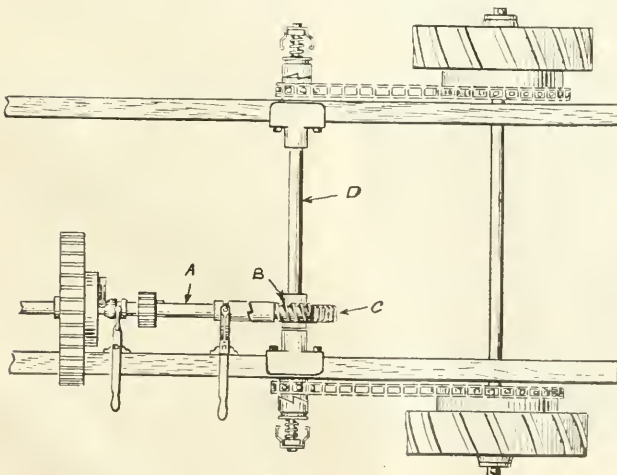


GENERAL VIEW SHOWING MIXING DRUM AND HOIST ON A SMALL BATCH MIXER

A Double-Drum Mixer

The Olsen Concrete Machy. Co., Elkhorn, Wis., announces the manufacture of a double-drum batch mixer. This equipment, which has been in use by A. G. Olsen since 1904 and was patented in Feb., 1909, is of interest in that two separate mixing chambers are used, one discharging into the other. In the first drum the materials are mixed dry. When mixed as desired they are transferred into the forward drum, where the water is added.

This mixer, which has been designed and built by A. G. Olsen, will be manufactured by the Olsen company. Readers may be interested, in this connection, in a mixer described in *Cement Age*, Apr., 1911, p. 210, in which a multiple compartment mixer is suggested.



TRACTION MECHANISM OF COLTRIN MIXER

Iron Studding Sockets

Various methods have been tried in fastening studding or posts to foundations in such farm buildings as corn-cribs, granaries, barns, hog-houses, coal houses, sheds, etc. The most common, perhaps, is that of "toenailing" the studding to a sill placed on the concrete floor or foundation. Experience, however, has proven that sills soon rot, owing to the fact that they lie flat down and hold the moisture. Steel wire nails

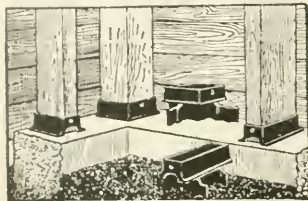


FIG. 1—ROSS SOCKET AS USED IN CONCRETE FOUNDATIONS

soon rust off, thus causing the building to burst at the bottom when any appreciable pressure is applied against the sides—spilling the contents.

In order to prevent buildings from bursting out at the bottom on account of wire nails rusting off, or sills decaying, a practical iron studding socket has been developed by G. M. Ross & Co., Grinnell, Ia. These sockets hold the upright studding or posts securely to the concrete floor or foundation, as the case may be, thus eliminating the use of sills. Openings in the sockets let moisture out. The post supports are made for studding dressed one side and one edge, and can be secured in sizes to fit any upright.

Ross sockets were put in actual use about eight years ago and are said to be highly recommended by

those who have had occasion to use them.

It is a very easy matter to set these sockets in place for they are simply tapped down into the floor or foundation before the concrete has set. Prongs guide them so that they will be properly in line, as the sockets are driven down to their shoulders which rest on the surface of the floor or foundation.

An interesting booklet is published by the manufacturer, containing directions for estimating quantity of material needed, placing temporary forms for concrete floors or foundations, mixing and placing the concrete, setting the sockets in place, etc. These directions are proving very helpful to many farmers as well as others.

A Long-Handled Geared Trowel

In a long-handled trowel, made by the Standard Tool and Mfg. Co., Indianapolis, the trowel blade is con-

trolled by a very ingenious arrangement. The socket for the handle is fastened to the blade with a pin bolt so that it can rotate freely in a quadrant and the blade can adopt any angle. This rotation, however, is controlled by a curved gear rack or gear segment fastened rigidly to the blade, meshing with a small bevel gear, about $1\frac{1}{2}$ " in diameter, which is fastened to the handle socket.

With this arrangement, the inclination of the trowel blade is easily controlled by the operator by simply twisting the handle in any direction. The accompanying sketch shows the general arrangement of this mechanism.

One of the special features is that the same control of this tool is possible as with a hand trowel. The operator can feel the surface, as it were. The blade can not tilt unless the handle is twisted.

In one model of this gear controller tilting trowel, the mechanism is enclosed in a dustproof case which prevents any cement or dirt from coming in contact with the gears.

Trade Publications

Hoist Tower Equipment—Archer Iron Wks., Chicago, 9" x 6", paper, 20 pp., illust. This catalog is limited to an intelligent and comprehensive discussion of hoist power equipment, and this subject is covered in detail. Towers, hoist buckets, hopper gates, swivel head connections, line gates, etc., are shown in detail.

Steel Forms—The Lambie Patents of Canada, Toronto, Ont., $9\frac{1}{2}$ " x $6\frac{3}{4}$ ", paper, 12 pp., illust. This catalog shows in detail steel forms developed by F. D. Lambie, N. Y. C., and residences constructed with these forms. Plans and elevations are shown of four-room and six-room houses.

Asbestos—Asbestos Corporation of Canada, Ltd., Montreal, P. Q., 9" x 7", paper, 26 pp., illust. This booklet is an interesting presentation of the mining and preparation of asbestos. Views of asbestos quarries are shown and the process of manufacture is described in detail.

Waterproofing for Stucco Houses—Ceresit Waterproofing Co., Chicago, 9" x 4", paper, 8 pp. This booklet discusses in an interesting way the problem of waterproofing concrete and stucco houses. While the booklet is written around a special material yet the way in which it is handled makes it of general interest.

Concrete Silos—McCoy Silo Form Co., Pittsburgh, 6" x $3\frac{1}{2}$ ", paper, 8 pp., illust. This folder describes some interesting phases of silo construction and shows some work recently completed.

Hand Shovels—The Conneaut Shovel Co., Conneaut, O., $8\frac{1}{2}$ " x 6", paper, 16 pp., illust. This catalog describes in detail a complete line of shovels, manufactured by improved methods.

(Continued on Advertising page 82)

June, 1914



SHOWING MECHANISM OF TILTING TROWEL

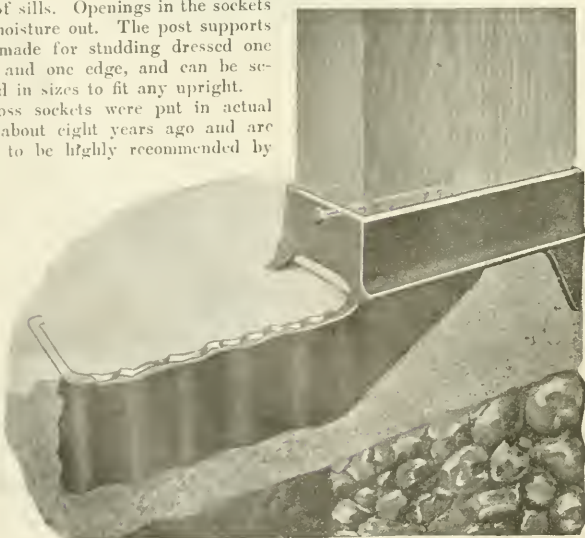
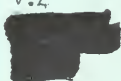


FIG. 2—ROSS SOCKET AS USED IN CONCRETE FLOORS

TA
680
C72
v.4

Concrete



ENGINEERING

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGINE STORAGE

